INTRUMENTACIÓN INDUSTRIAL DE PROCESOS

DIPyGI FACET - UNT

TEMA Nº7

Elementos Finales De Control

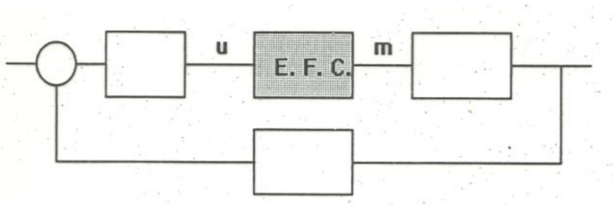
Distintos elementos finales de control. Válvulas reguladoras, descripción general, tipos y características. Accionamiento neumático, retardos. Dimensionamiento de válvulas: flujo crítico, vaporización y cavitación, efecto de la viscosidad. Selección de válvulas de control. Posicionador

Los elementos finales de control son los **dispositivos encargados de transformar una señal de control en un flujo de masa o energía (variable manipulada)**. Es esta variable manipulada la que incide en el proceso causando cambios de la variable controlada. Lo más común en procesos es que la manipulación sea un caudal. Para ajustar el flujo de fluidos en una línea existen primariamente dos mecanismos:

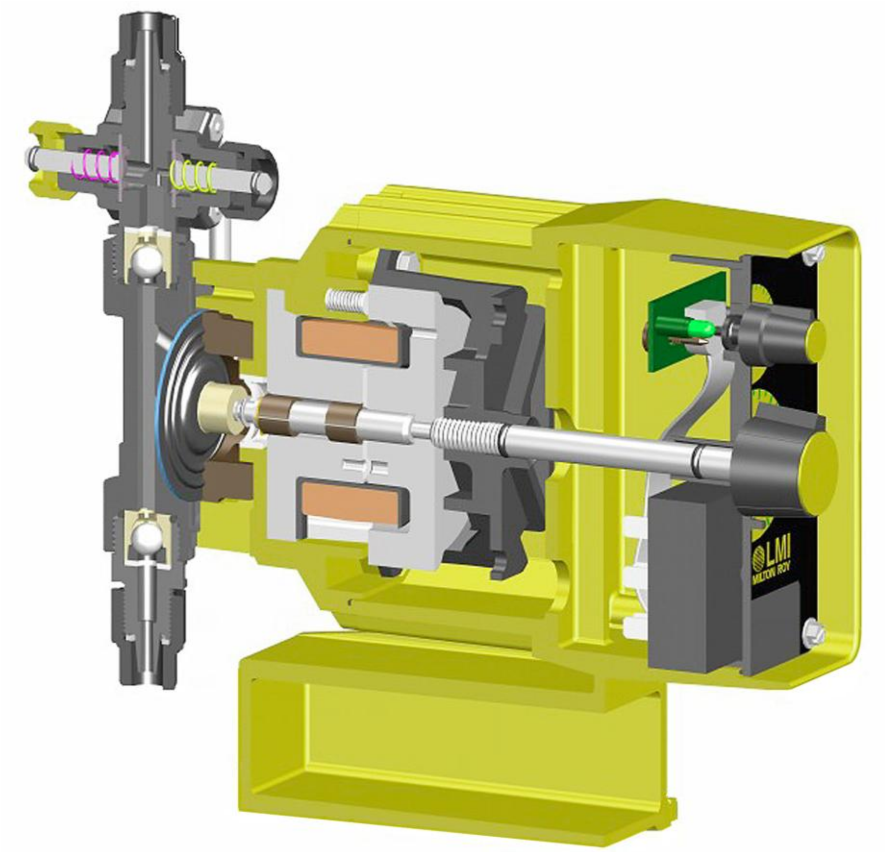
- Modificar la *energía entregada* al fluido (bombas y ventiladores de velocidad variable)
- Modificar la *resistencia* al paso del fluido (válvulas, registros en ductos de gases)

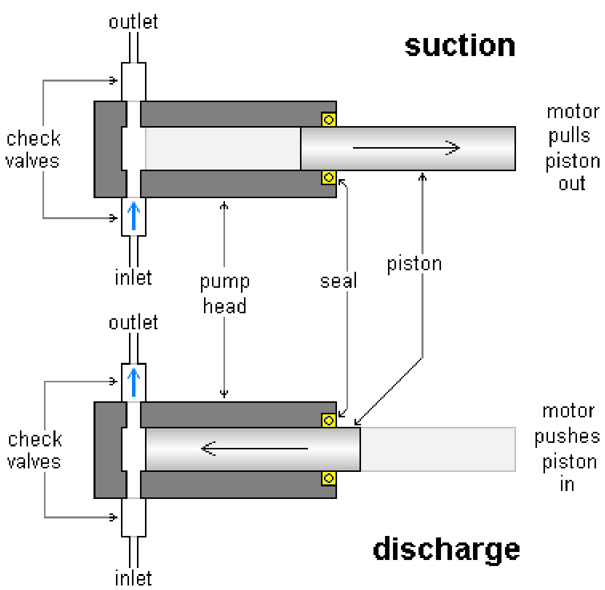
De los diversos elementos finales de control, el de más amplia difusión es la válvula automática con actuadores neumáticos o eléctricos. Pero también están los siguientes tipos:

- Válvula con actuador neumático
- Bomba centrífuga o de desplazamiento positivo con motor de velocidad variable
- Bombas dosificadoras
- Registros para conductos de circulación de aire o gases
- Ventiladores con accionamiento de velocidad variable
- Contactos para resistencias eléctricas
- Válvulas rotatorias para sólidos
- Válvulas de cuchilla para sólidos
- Esparcidores de paletas para sólidos
- Cinta transportadora de sólidos

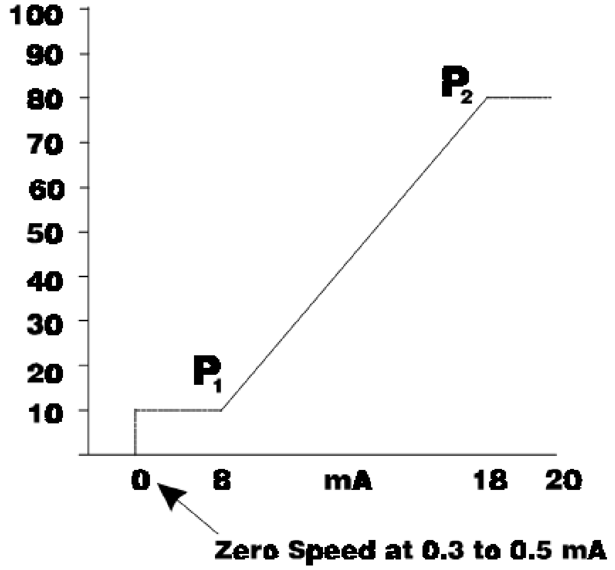


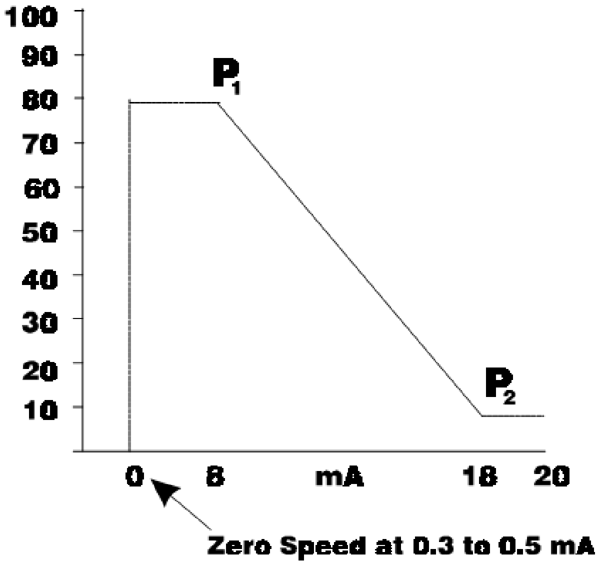
BOMBAS DOSIFICADORAS



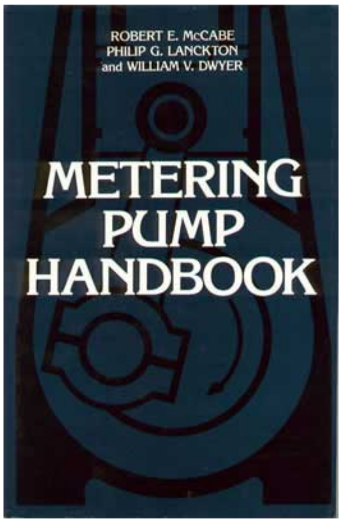


- **4 - 20 mA (Slope Adjustable)**
  Programmable 4 - 20 mA or
  0 - 20 mA response direct or inverse





Metering Pump Handbook



As its name implies, this is the complete manual for metering pump designers, a practical guide for engineers working in all process industries, and a useful workbook for engineering students. It was written in response to the need for an authoritative engineering reference on the design, application, and maintenance of metering, or controlled-volume pumps. The first publication was to deal with the special pumping problems associated with liquid metering systems in process industries, this one comprehensive volume brings together information previously scattered among technical reports, journals, and manufacturer's catalogs.

Major topics covered include: power end mechanisms; valving; packing and diaphragms; lubrication; control mechanisms; selection; operation principles; noise; testing; construction; multi-head pumps; safety; and much more.

Clearly and concisely, the **Metering Pump Handbook** presents all basic principles of the positive displacement pump; develops in-depth analysis of the design of reciprocating pumps and their piping systems; and demonstrates the practical implementation of these concepts through examples of actual pump applications.

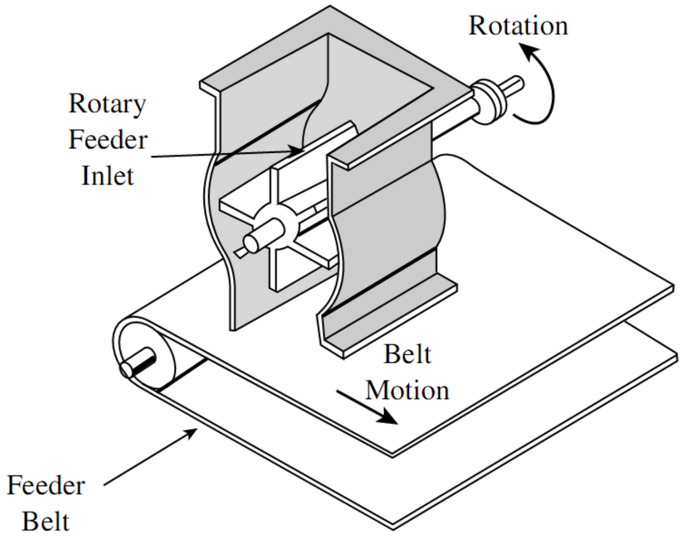
Features

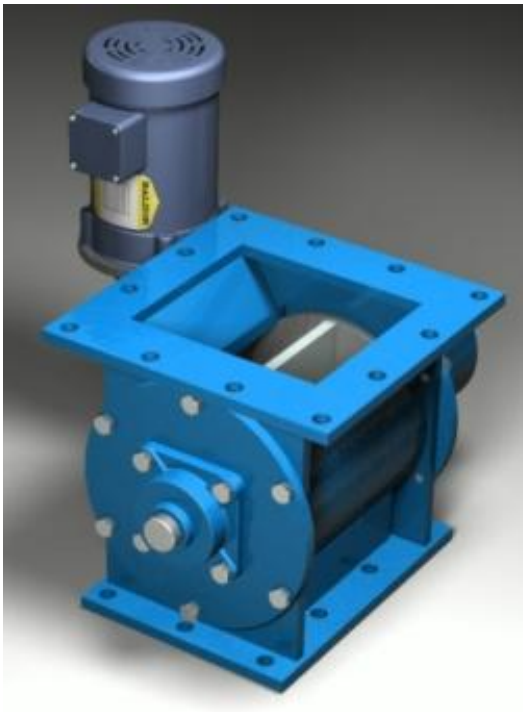
- Fundamentals of pump operation
- Principles of pump and piping system design
- Guidelines for selecting adequate materials of construction
- Examples of metering pump applications to process operations
- Procedures for sound installation, operation, and maintenance of pumps
- General formulas, tables, charts, and pumping system layouts

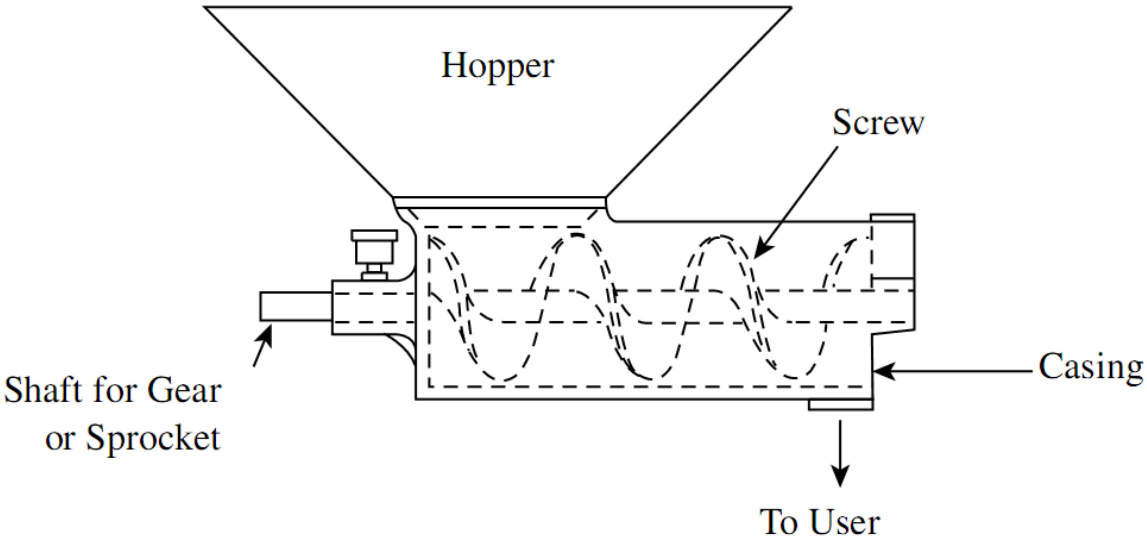
*Above was taken from the inside cover of the **Metering Pump Handbook**, McCabe, Lanckton, and Dwyer; Industrial Press, Inc., NY, 1984.*

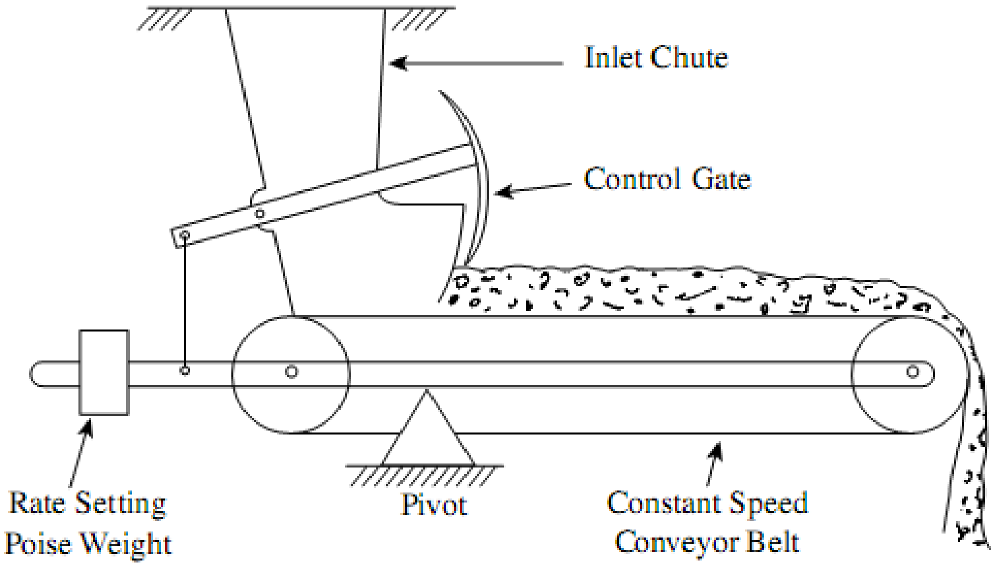
The **Metering Pump Handbook**b> can be purchased through online bookstores or major book retailers.

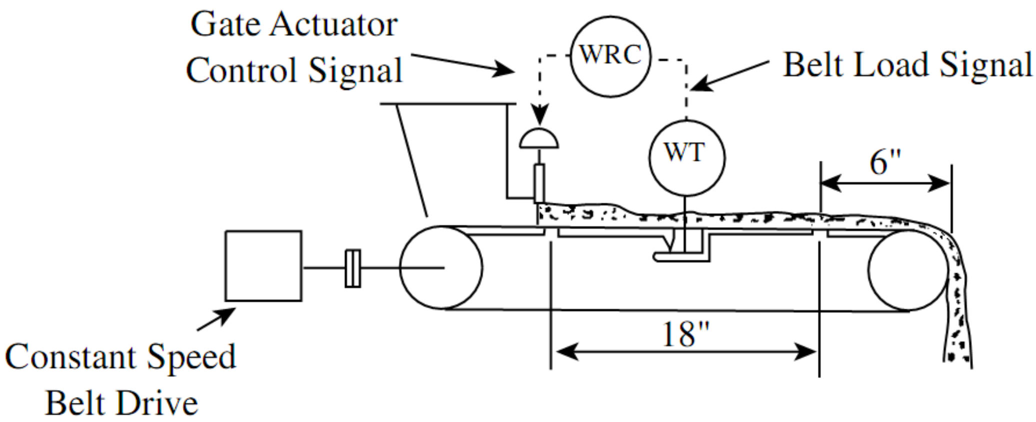
ELEMENTOS PARA MANEJO DE FLUJO DE SÓLIDOS











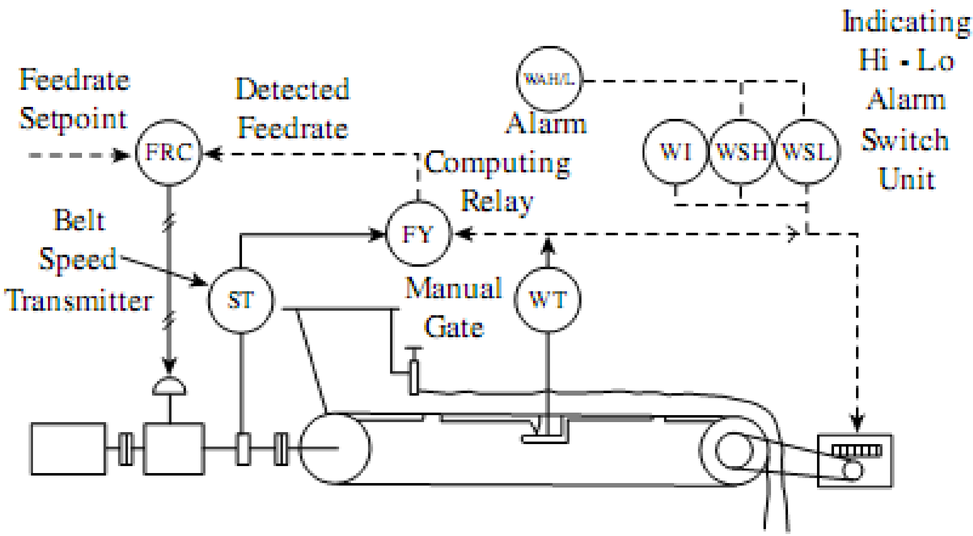
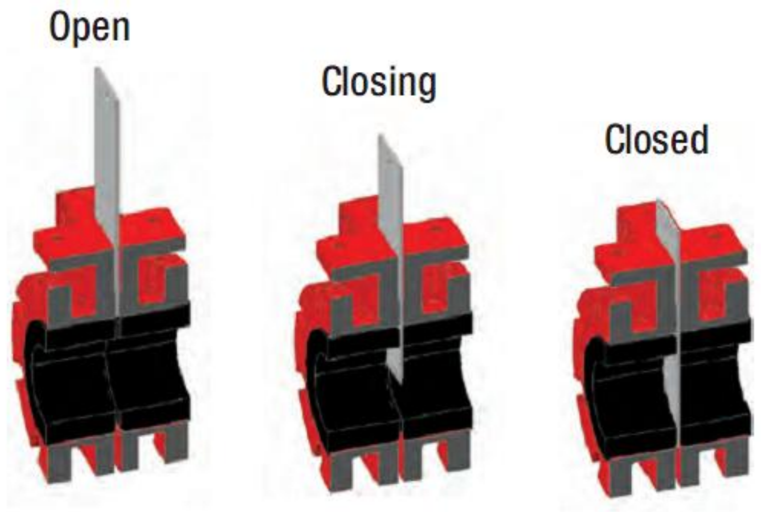


FIG. 2.23l

Speed-controlled belt feeder with both set-point and measurement in feed rate units.

VÁLVULAS PARA MANEJO DE PASTAS PESADAS Y SÓLIDOS A GRANEL



Series DX Slurry Knife Gate Valve

DISPOSITIVOS PARA MANIPULACIÓN DE CAUDALES DE GASES A PRESIONES BAJAS Y MEDIAS

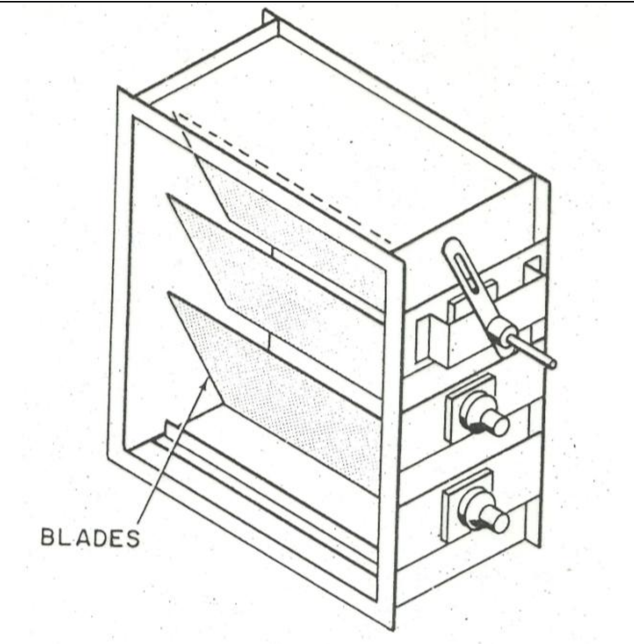
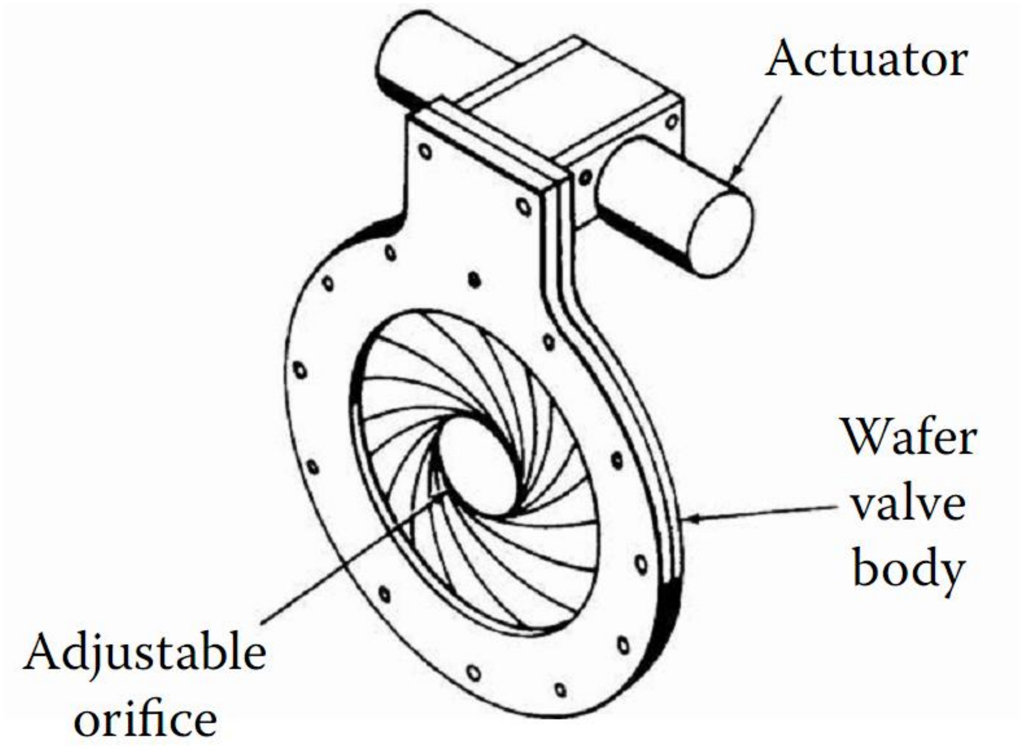


Fig. 2.4b Parallel-blade damper



Variable-orifice or iris damper.

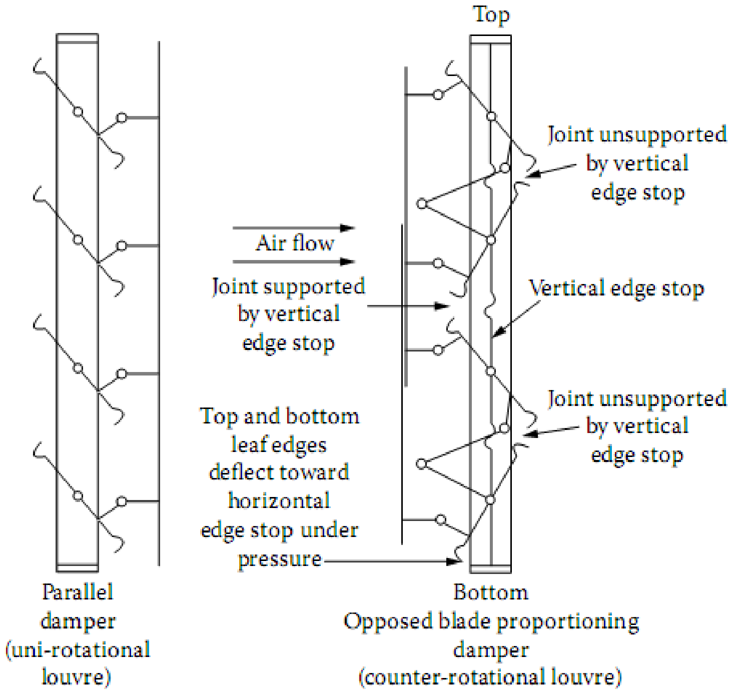
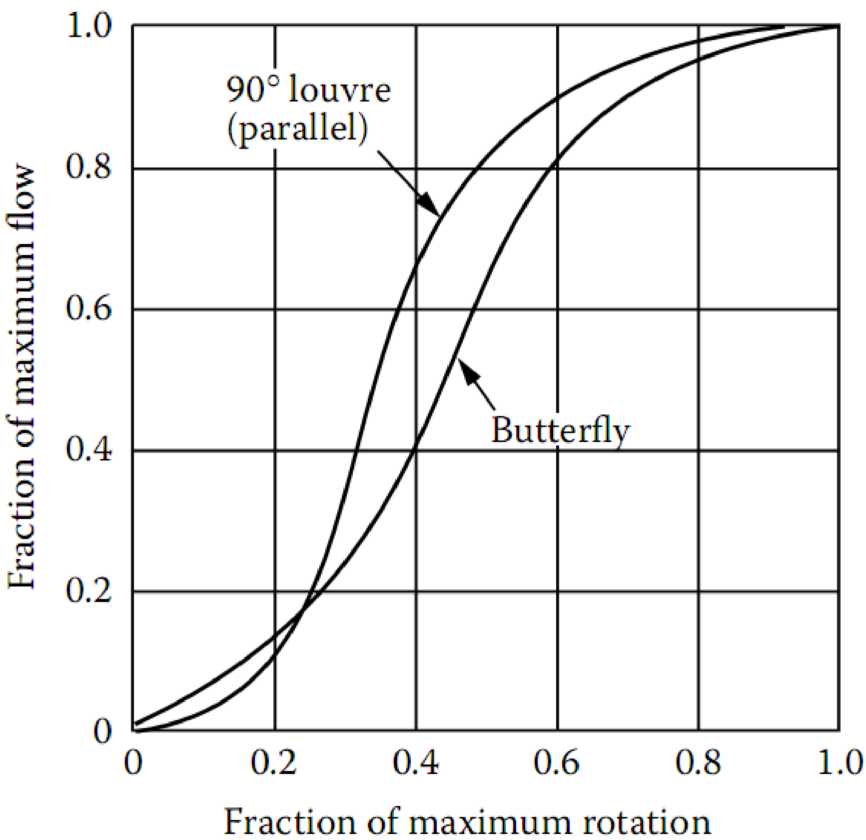


FIG. 7.1a

The designs of the parallel-blade and opposed-blade dampers, which are also referred to as uni-rotational and counter-rotational louver designs.



The flow characteristics of a parallel-blade damper are similar to those of a conventional butterfly valve

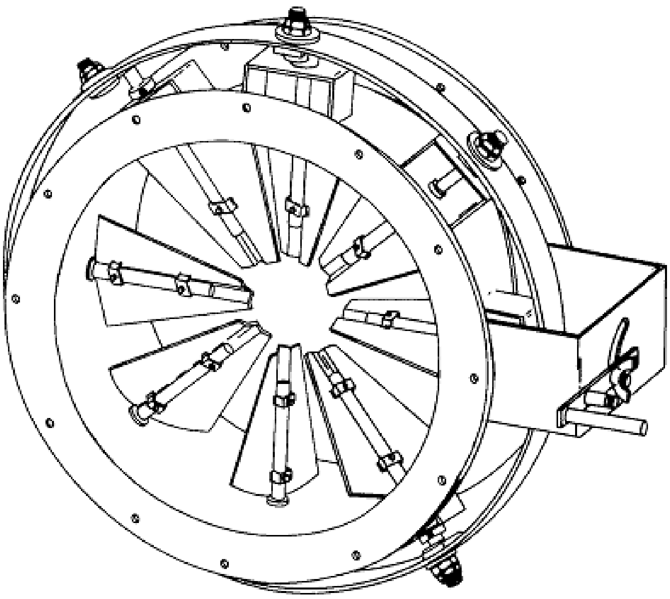
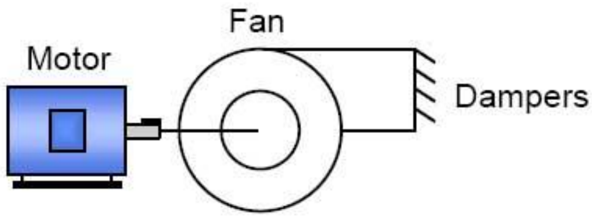
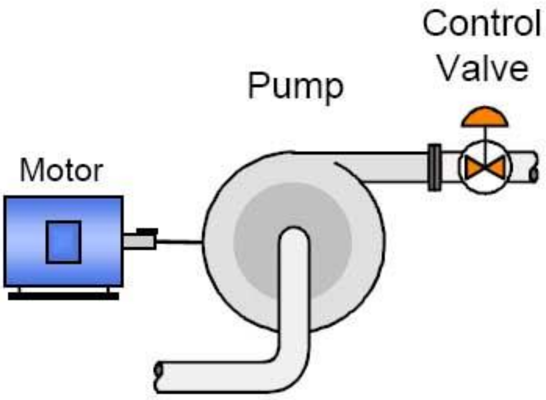
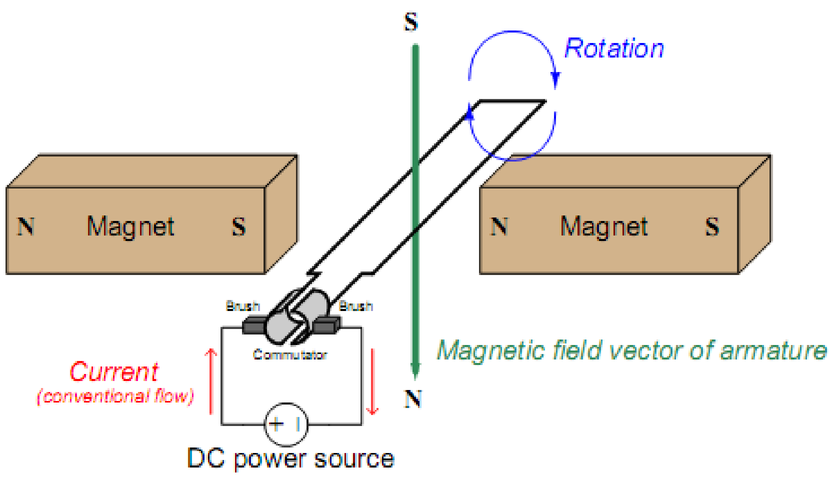


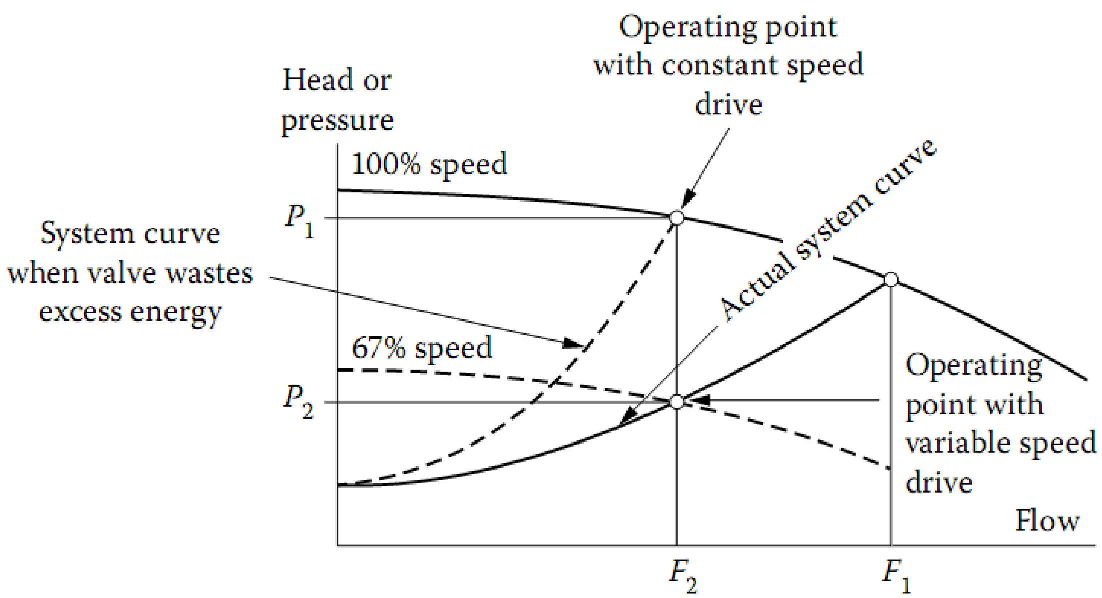
FIG. 7.1j
Radial vane dampers are used to throttle the flow on the suction side of air fans and blowers.

BOMBAS DE VELOCIDAD VARIABLE









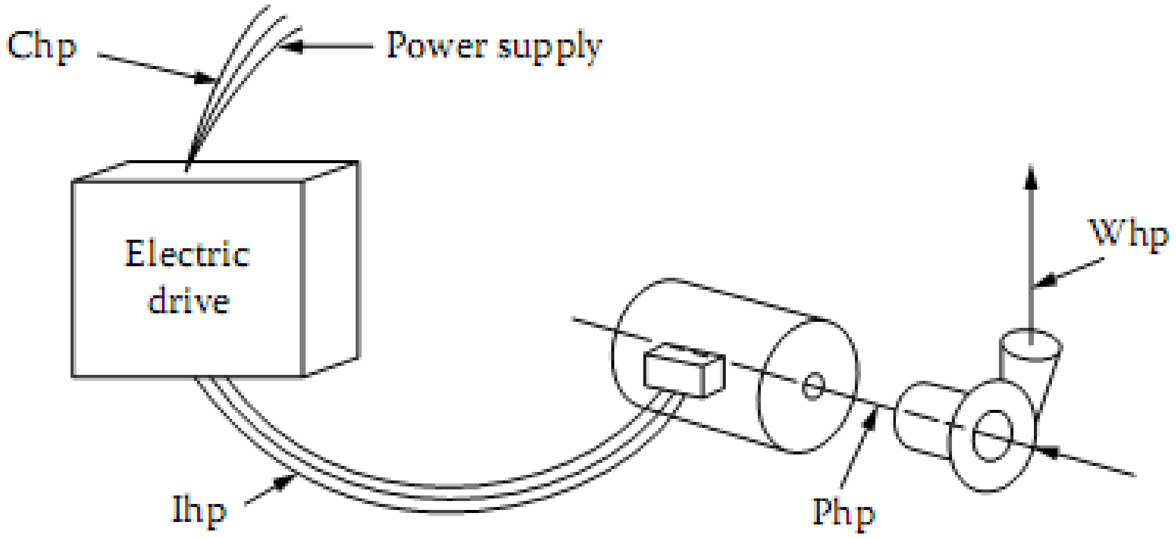


FIG. 7.10x
The configuration of a pump provided with an electrical variable-speed drive.

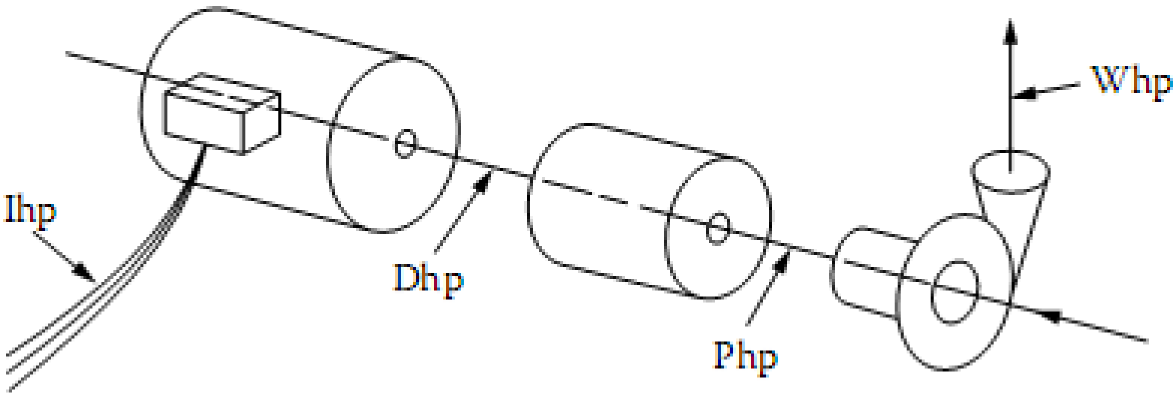
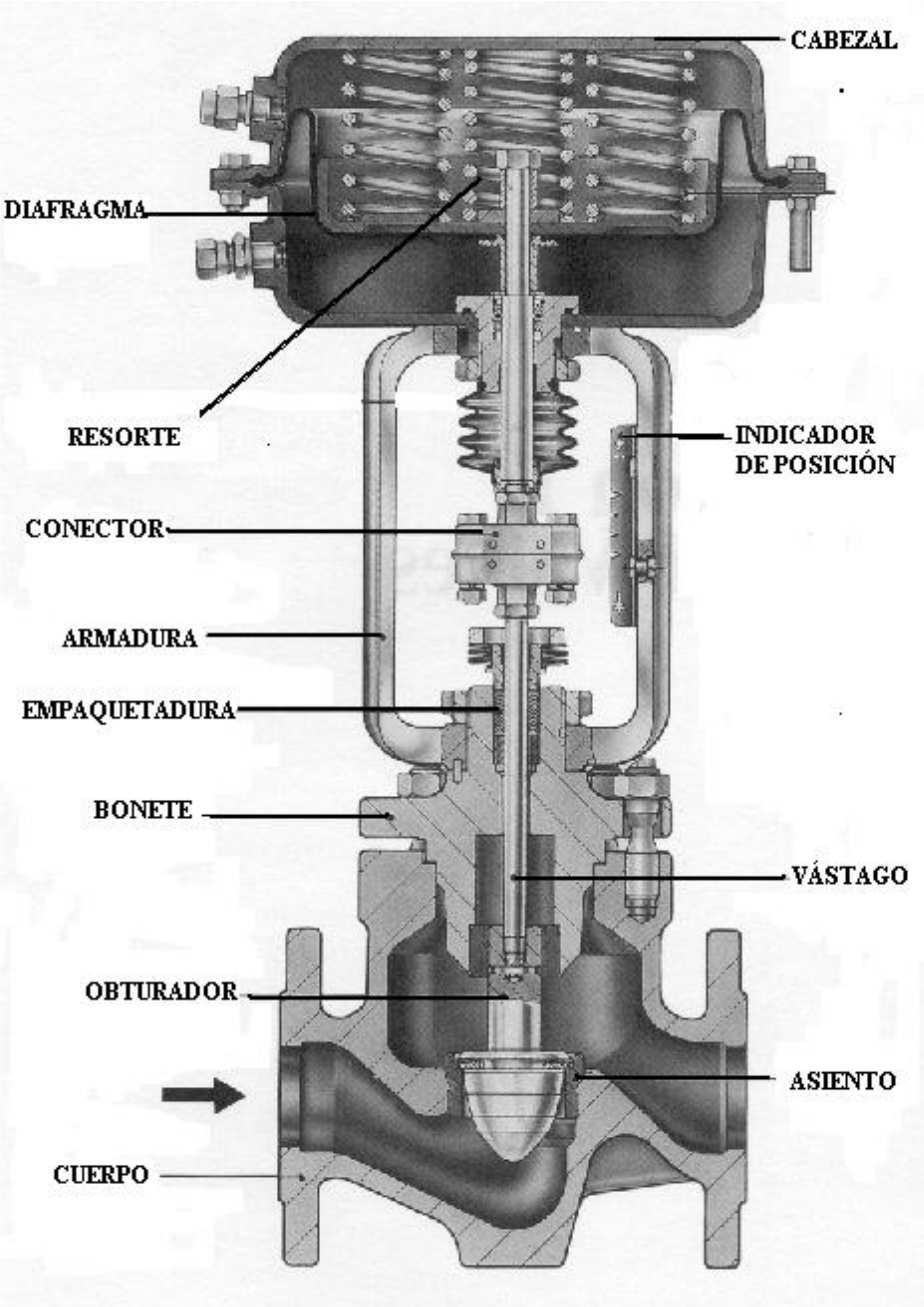


FIG. 7.10y
The configuration of a pump provided with an electomechanrical variable-speed drive.

VÁLVULAS DE CONTROL

La válvula de control es básicamente un orificio variable por efecto de un actuador. **Constituye el elemento final de control en más del 90 % de las aplicaciones industriales**. En la figura siguiente se ve una válvula globo con un actuador neumático de diafragma en donde se indican las diversas piezas que la constituyen



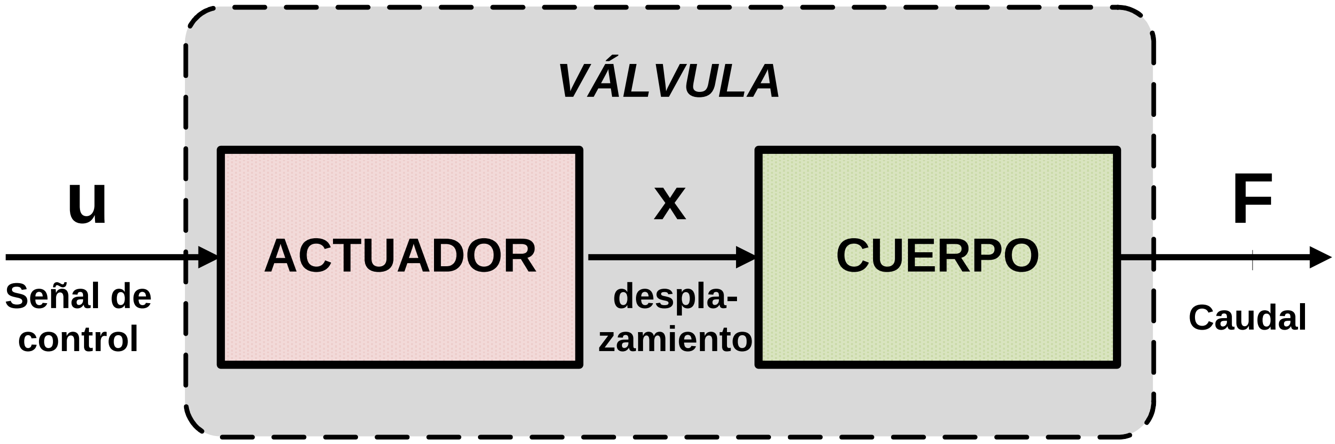
Corte de una válvula de control con sus partes

La válvula utiliza una **señal externa** que puede ser **neumática o eléctrica** y posteriormente transformada en una de tipo neumática que incide el cabezal.

Estos elementos los podemos considerar constituidos por dos partes:

- **Actuador:** recibe la señal de controlador y la transforma en un desplazamiento (lineal o rotacional) merced a un cambio en la presión ejercida sobre el diafragma.
- **Cuerpo:** el diafragma está ligado a un vástago o eje que hace que la sección de pasaje del fluido cambie y con ésta el caudal.

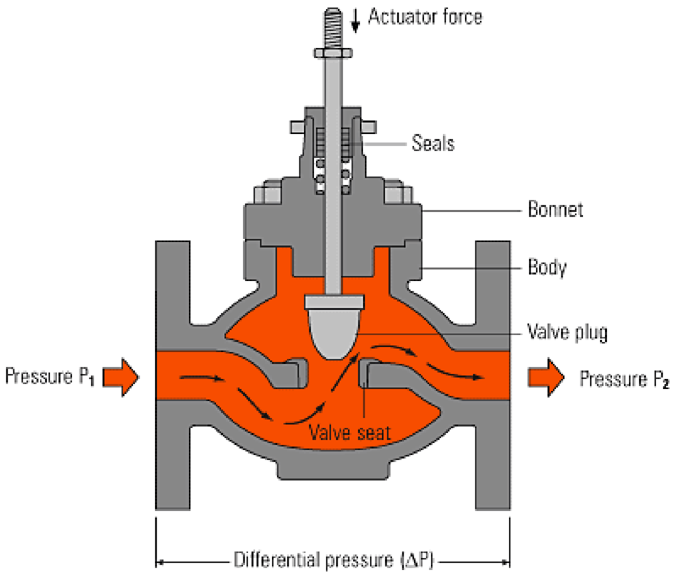
Con un diagrama en bloques se puede representar a la válvula como un sistema en serie.

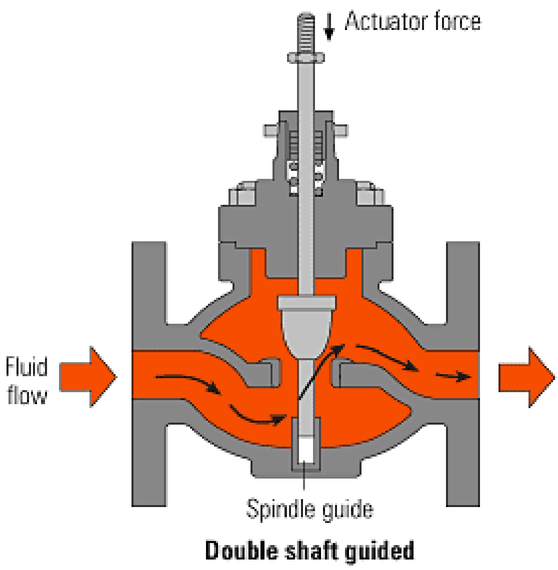


Desde el punto de vista estático el actuador es moderadamente lineal y la dinámica más significativa es la de llenado del cabezal con una constante de tiempo del orden de los segundos.

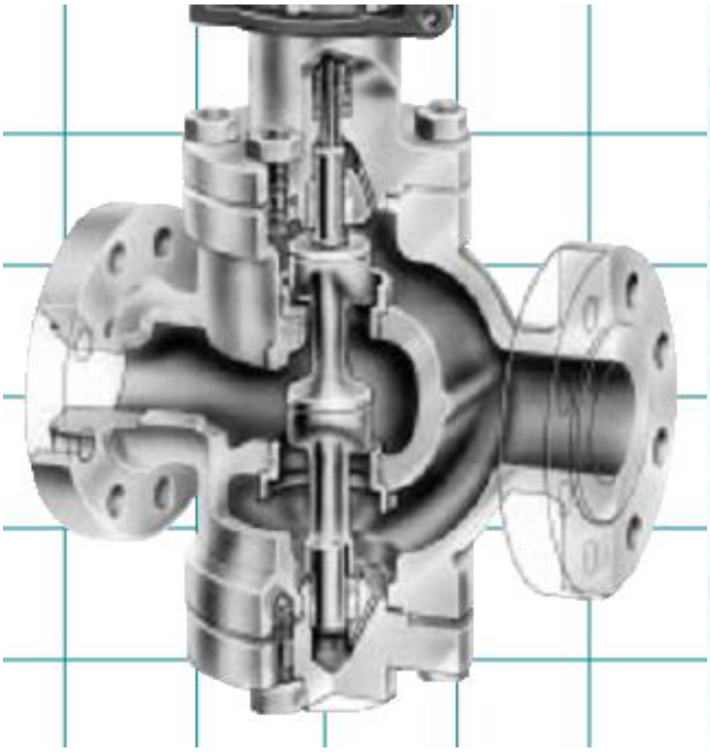
El cuerpo carece de retardo y la ganancia viene determinada por la característica de flujo instalada.

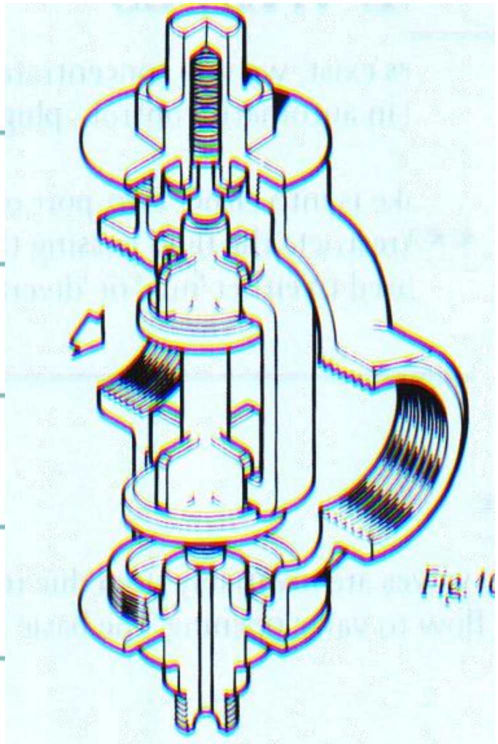
VÁLVULAS GLOBO

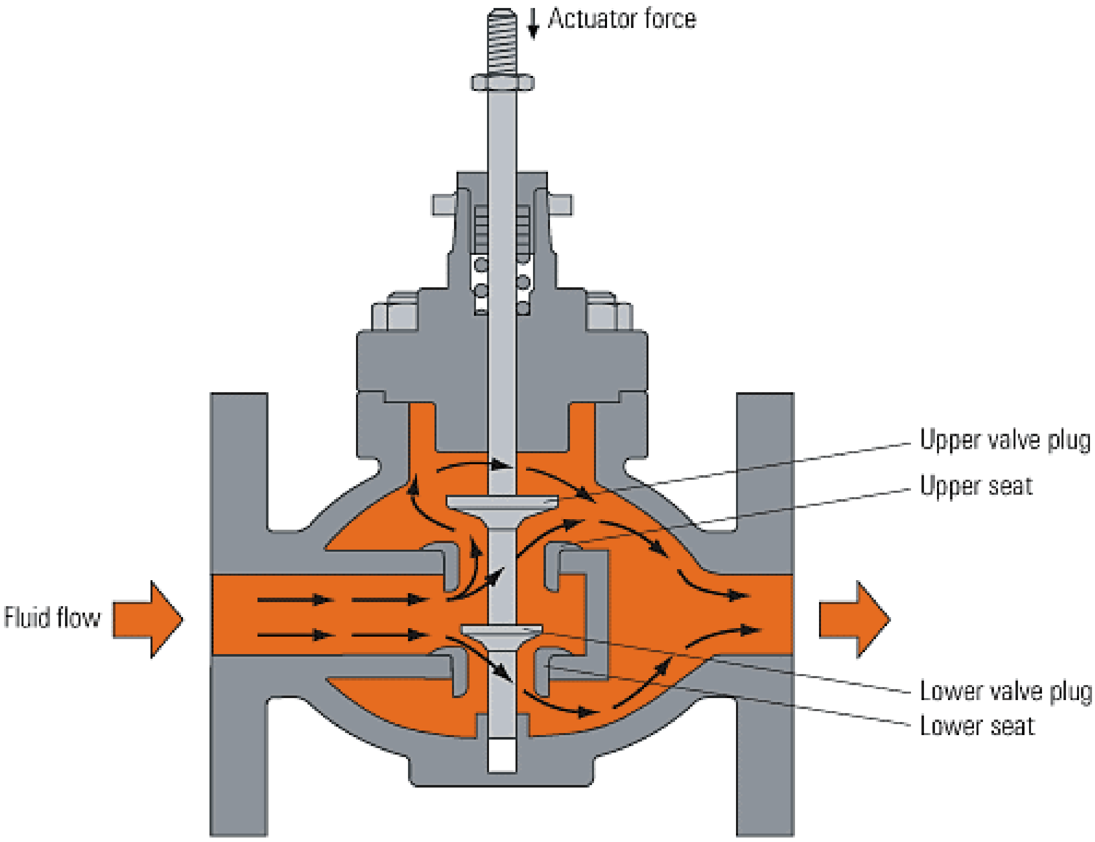




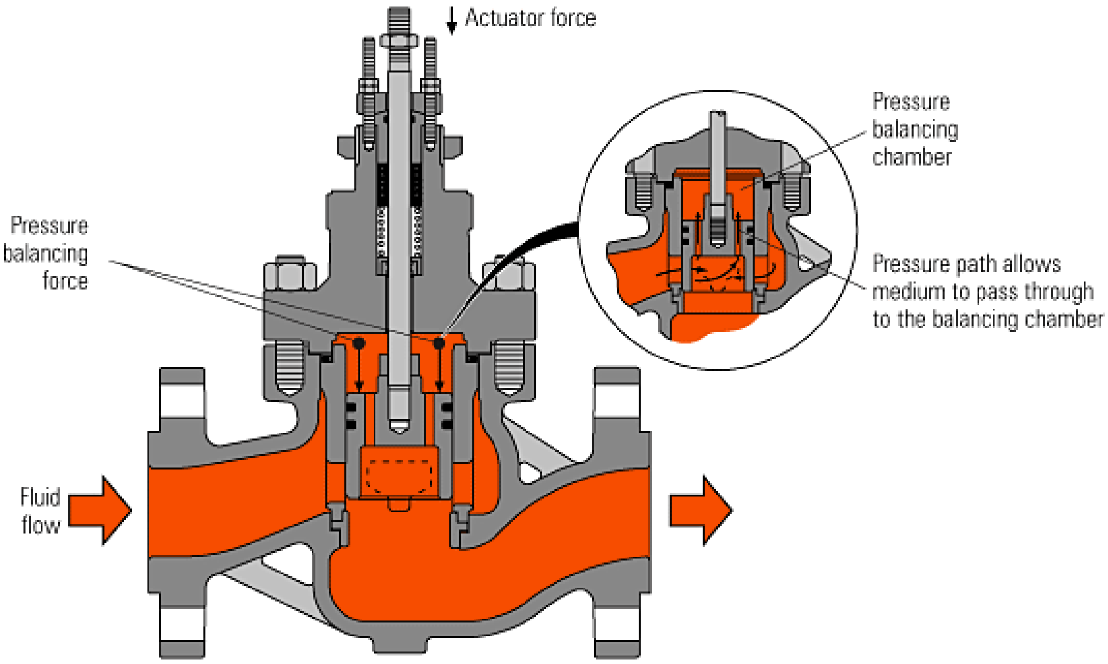
Un solo asiento – Guiada en el tope y con doble guía



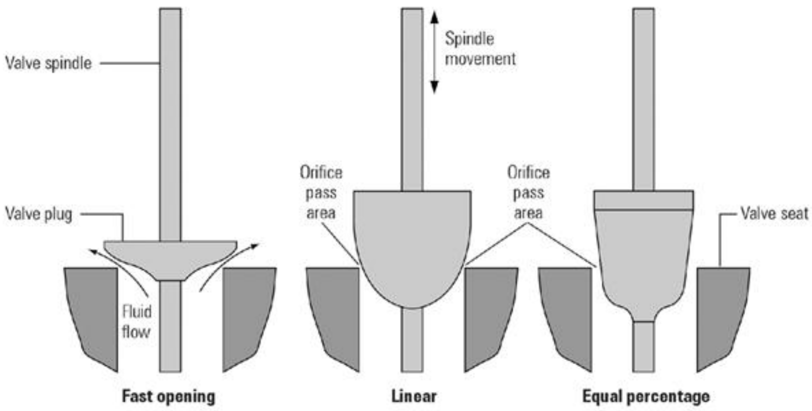


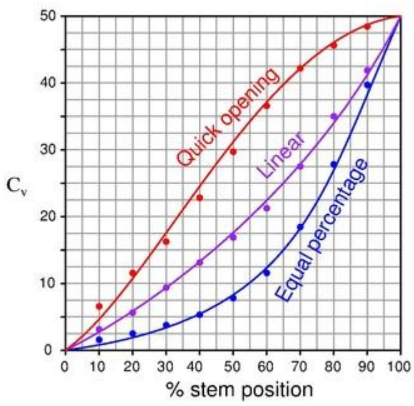


Doble asiento – Guiada en tope y fondo

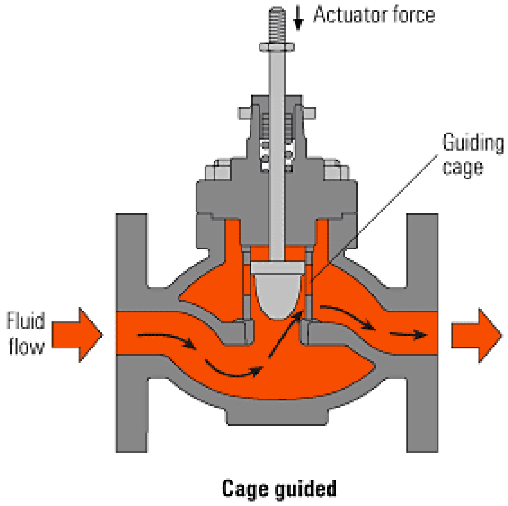


ASIENTO BALANCEADO





OBTURADORES CARACTERIZABLES



GUIADA EN CAJA

W0958/IL

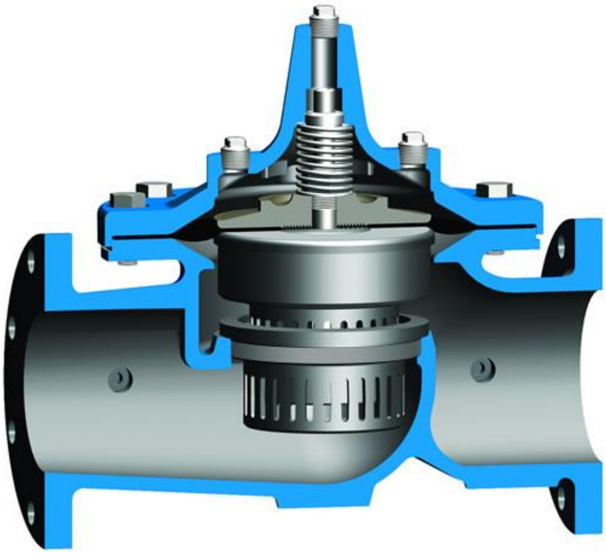
QUICK OPENING

W0959/IL

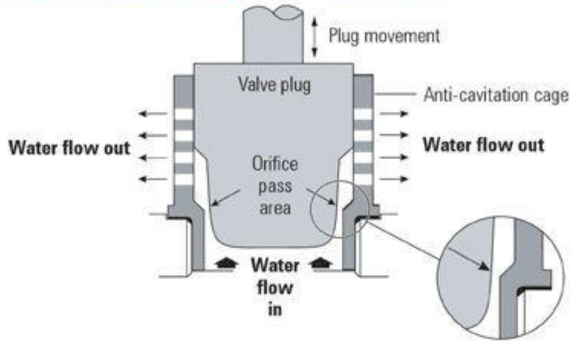
LINEAR

W0957/IL

EQUAL PERCENTAGE

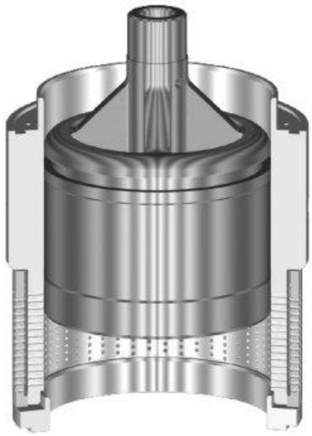


Example of anti cavitation trim from Spiraxsarco.

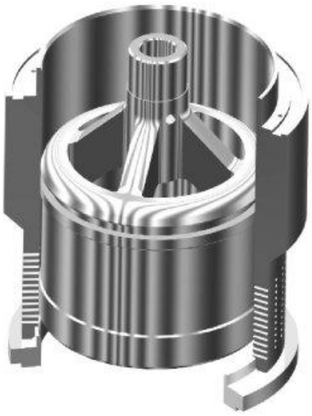


ANTI CAVITACION

Trim Types

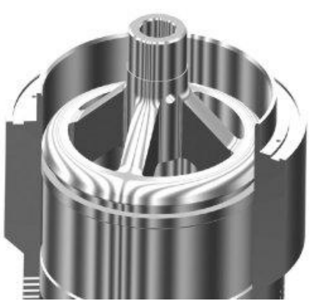


Models 41355 - 41555 - 41655 - 41955
Multi-Stage
Low Noise Trim FTO

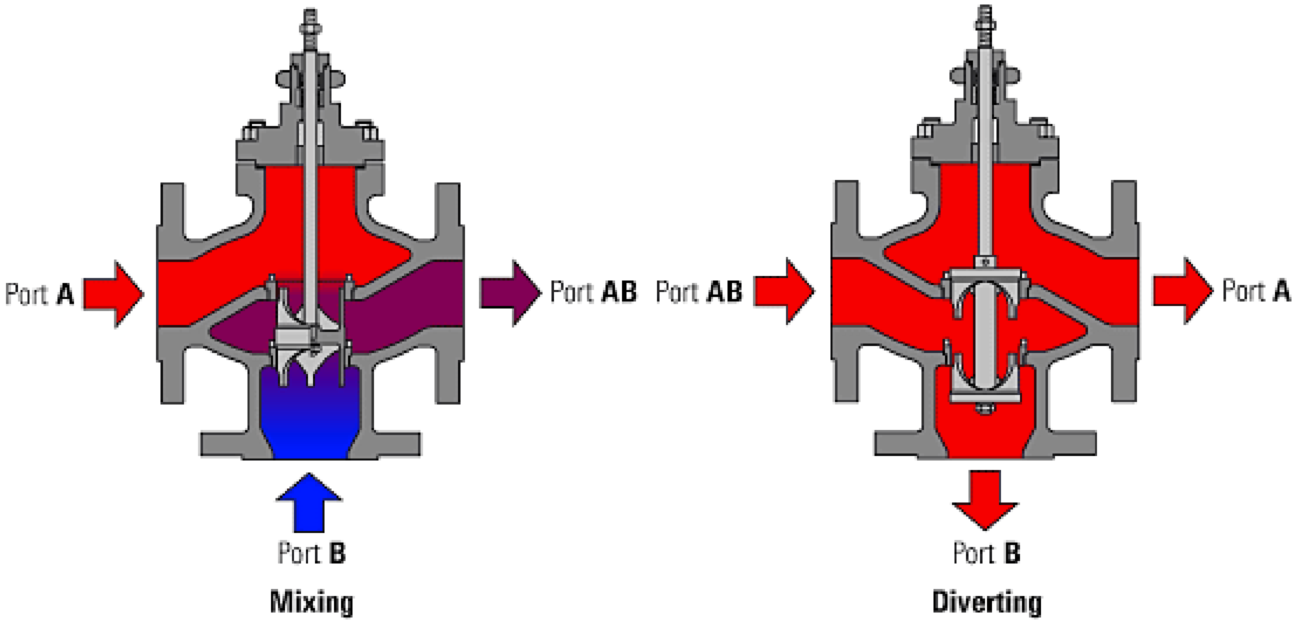


Models 41335 - 41535 - 41635 - 41935
Single Stage
Low Noise Trim FTO
Anti-Cavitation Trim FTC

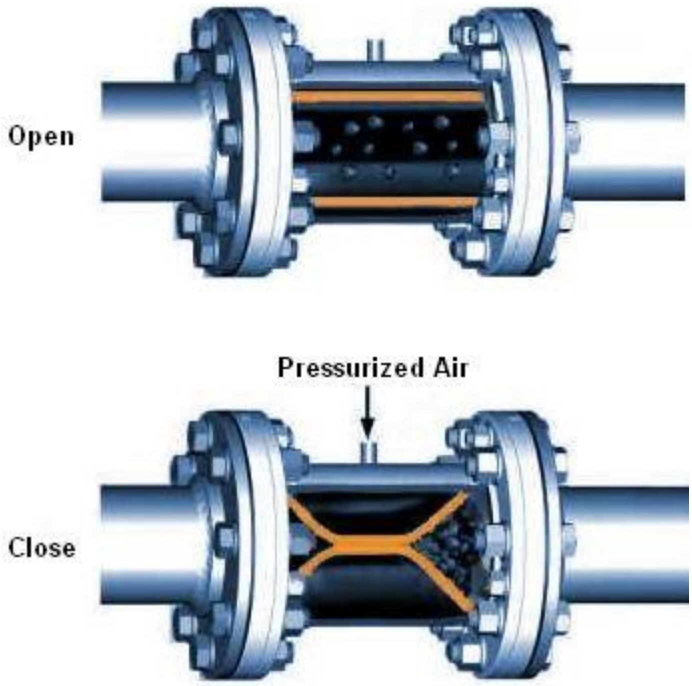
Models 41395 - 41495 - 41595 - 41995
Multi-Stage
Anti-Cavitation Trim FTC



VÁLVULAS GLOBO DE TRES VÍAS



VÁLVULAS PINCH



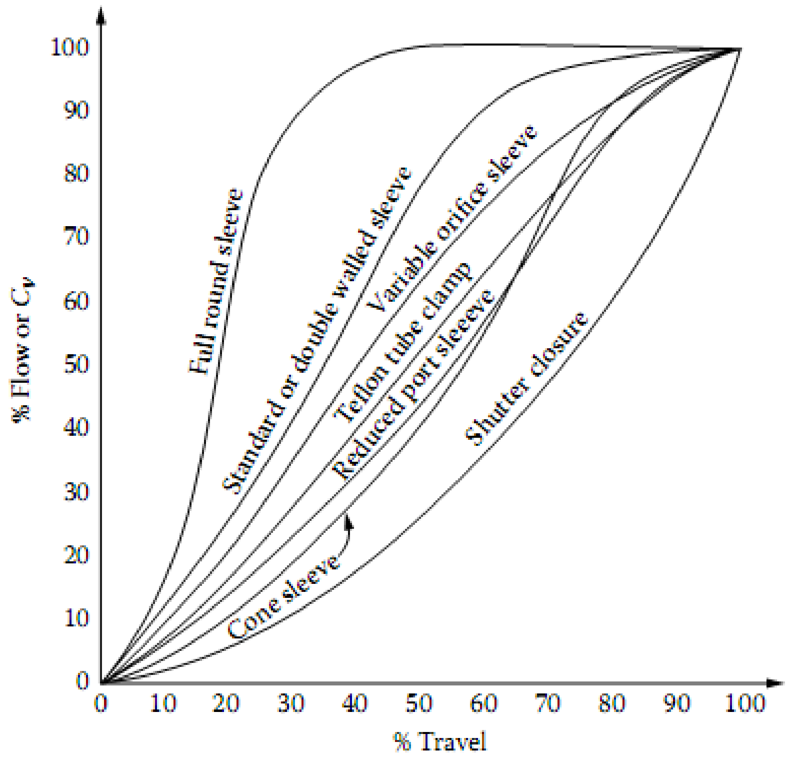


FIG. 6.20b
The characteristics of a full round sleeve is nearly quick opening. Double-walled or cone-shaped sleeve cross-sections bring the characteristics closer to linear.

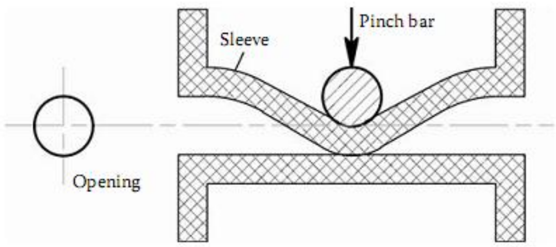
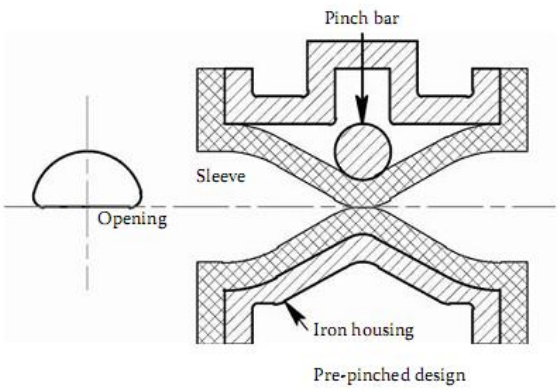


FIG. 6.20n
Full ported and fully round single pinch design.



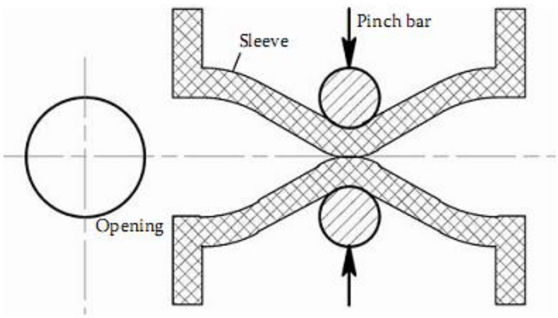
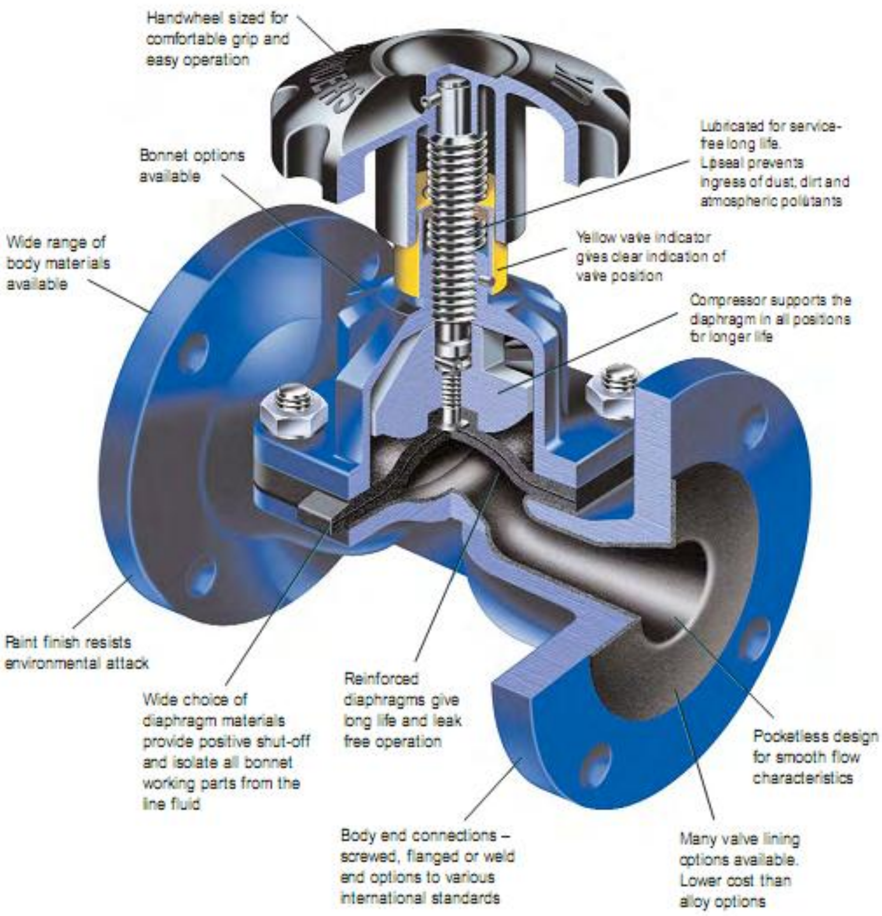
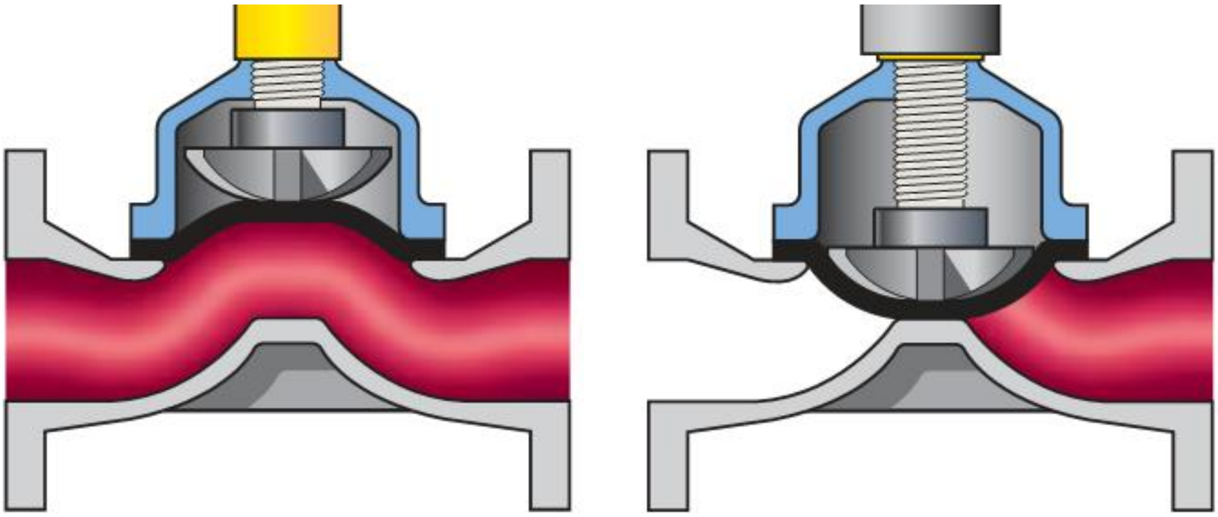


FIG. 6.20p
Fully round and full ported dual pinch mechanism.

FIG. 6.20o
Prepinched design.

VÁLVULAS SAUNDERS





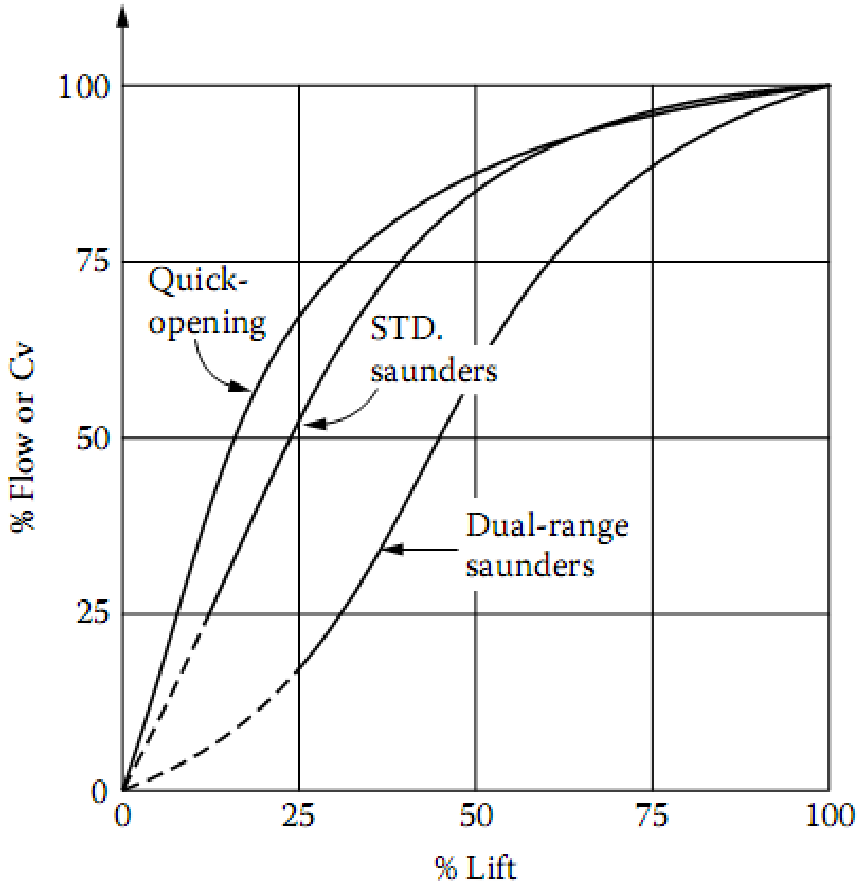
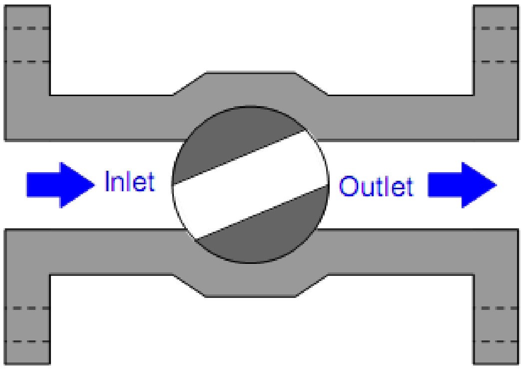


FIG. 6.22b

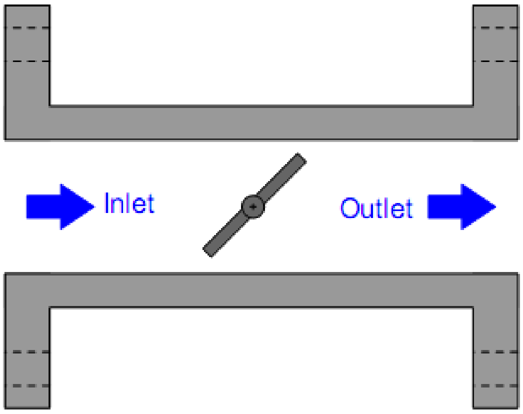
The characteristics of conventional Saunders valves are nearly quick opening, while the characteristics of dual-range Saunders valve designs are closer to linear.

VÁLVULAS ROTACIONALES

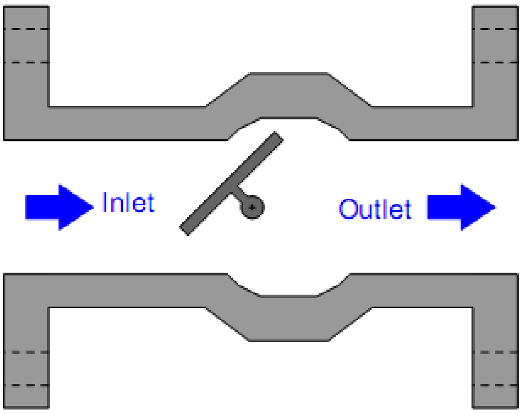
Ball valve

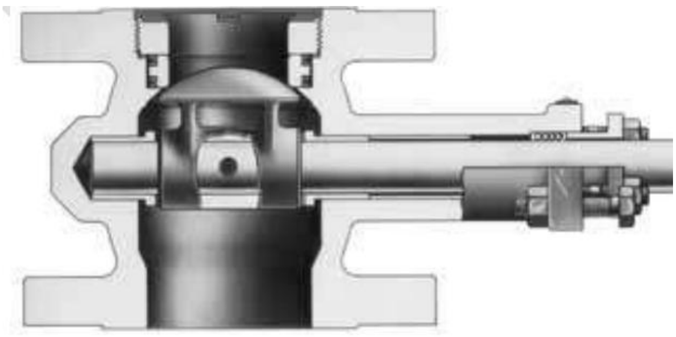


Butterfly valve

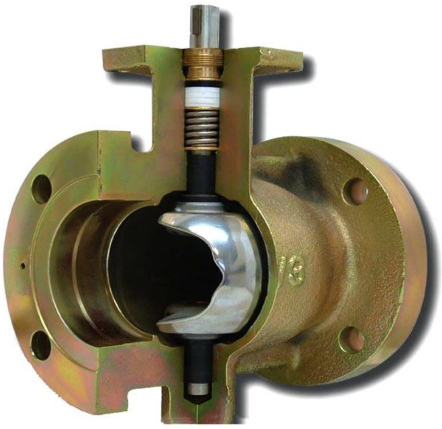


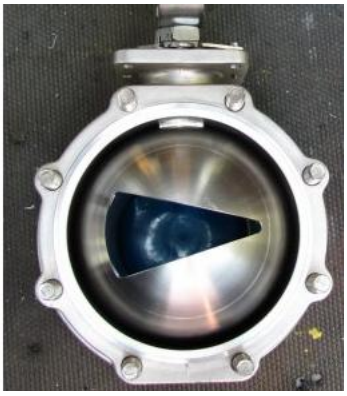
Disk valve

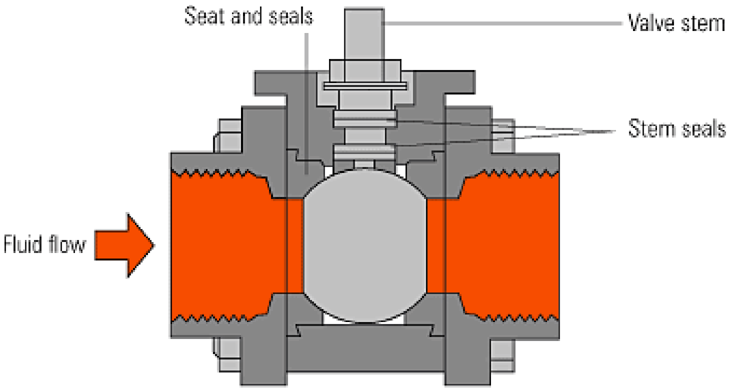




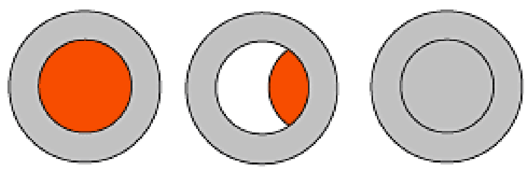
VÁLVULAS ESFÉRICAS

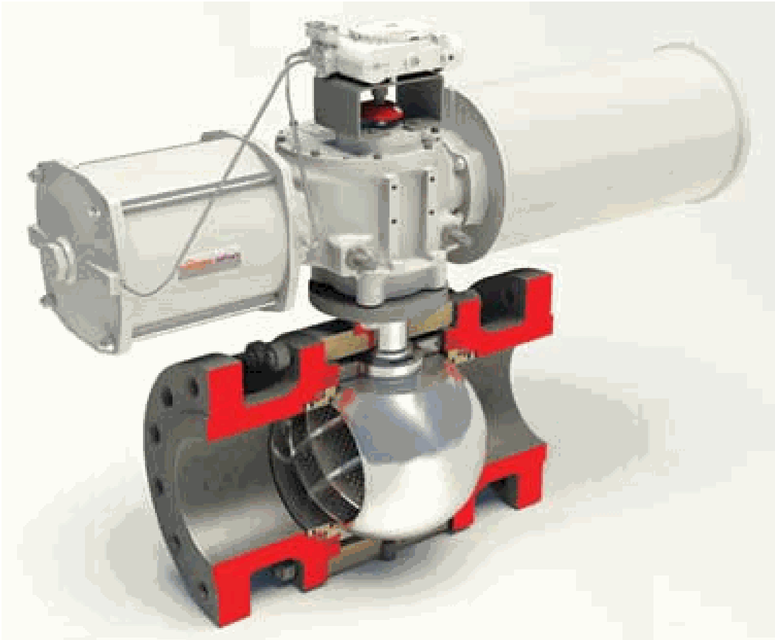






End view of the ball within the ball valve at different stages of rotation





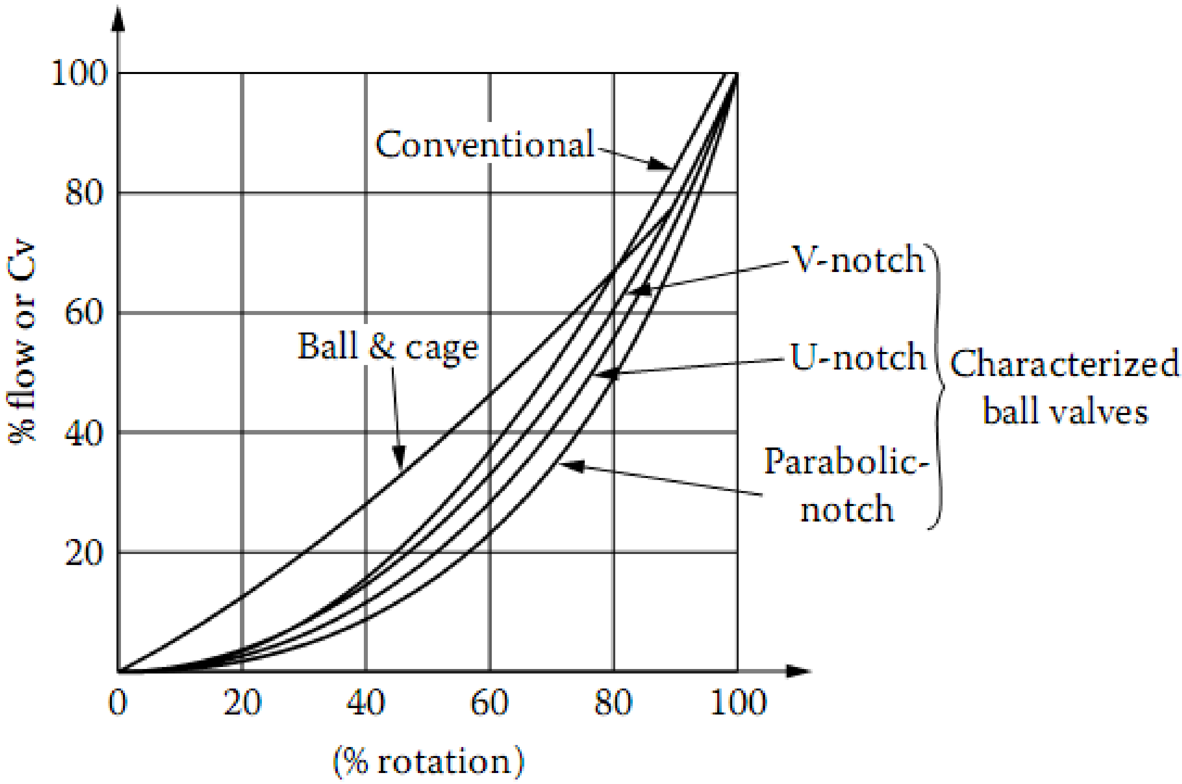
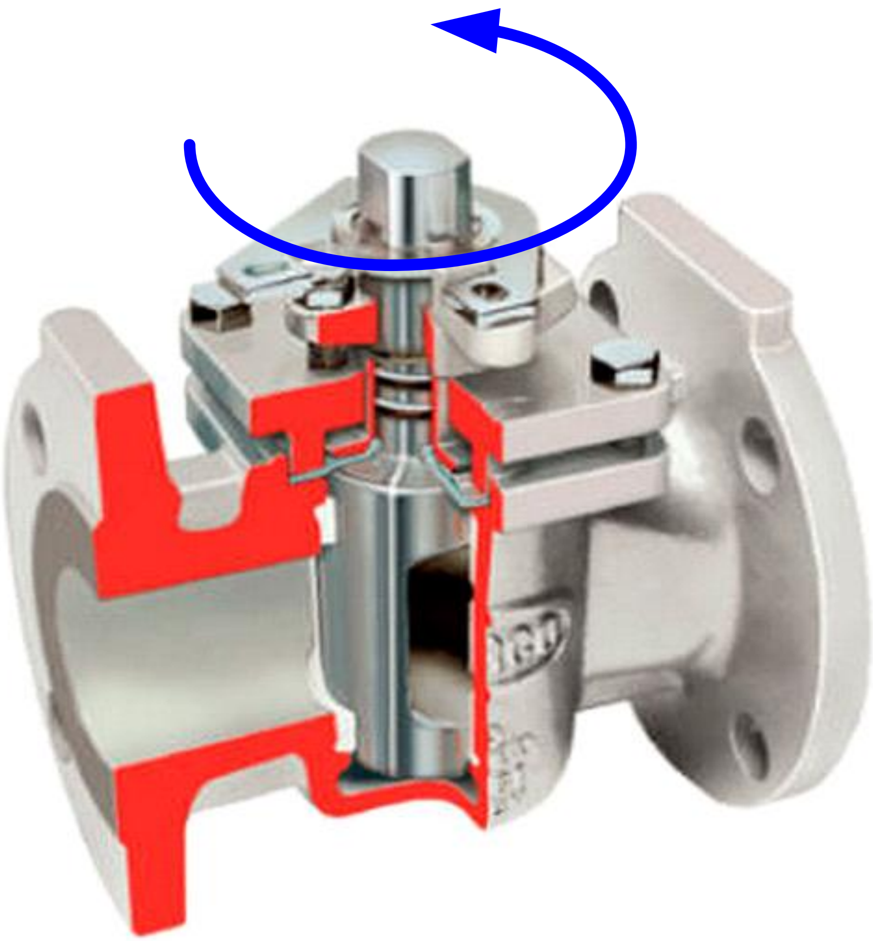
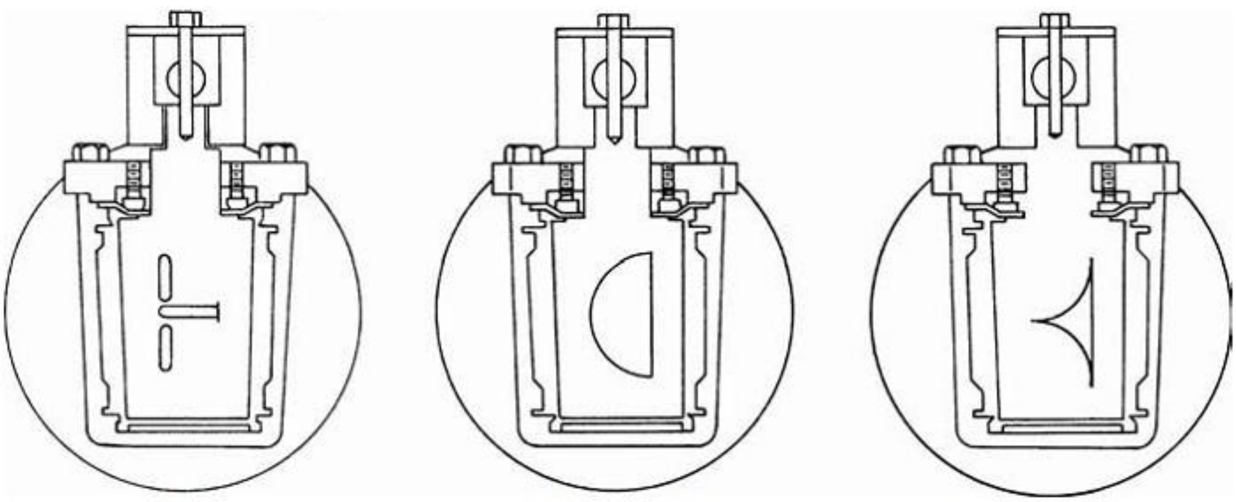


FIG. 6.16a

The characterized ball valve with a parabolic notch is near-equal-percentage, while the ball-and-cage valve characteristics are closer to linear, when used on water service. On gas service at critical velocities, the characterized ball valve's performance lines move closer to linear.

VÁLVULAS TAPÓN (plug)





Modified linear Modified parabolic Equal percentage

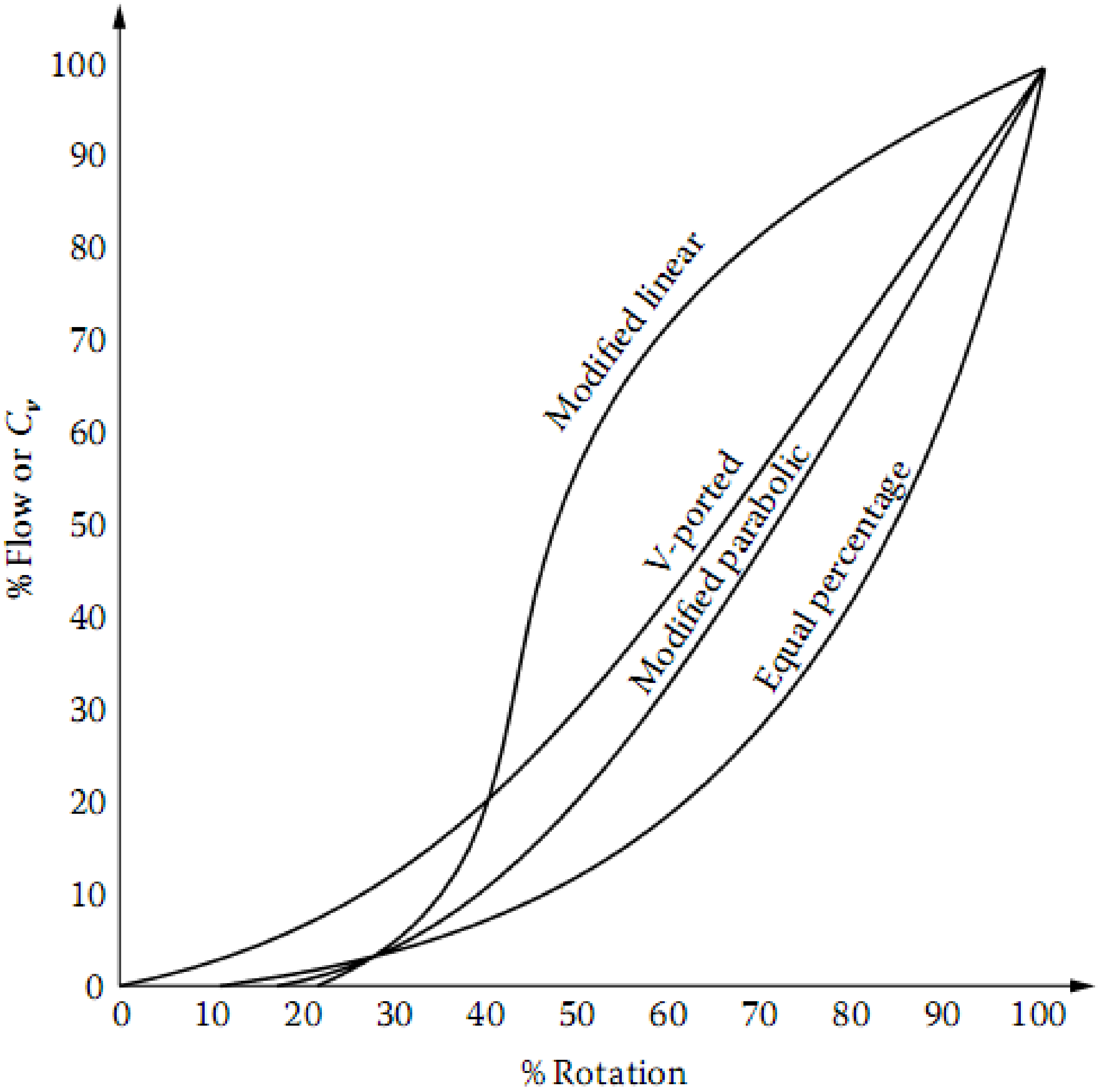
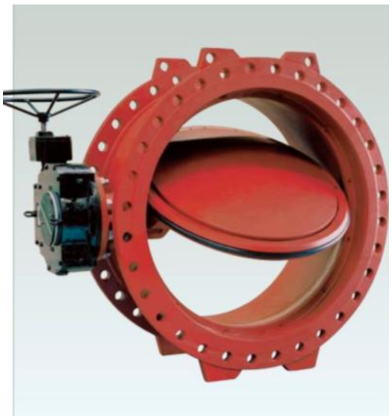
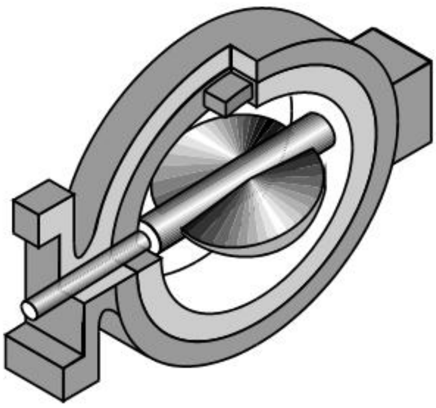


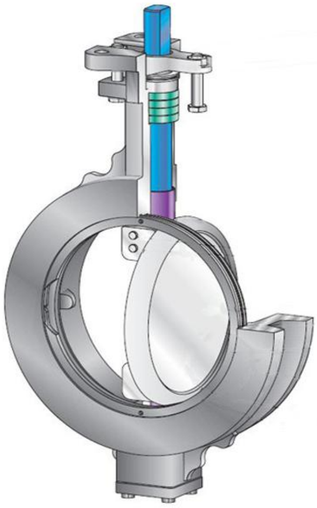
FIG. 6.21a

Plug valve characteristics are a function of the type of the particular V-port or of the shape of the throttling plate used.

VÁLVULAS MARIPOSAS







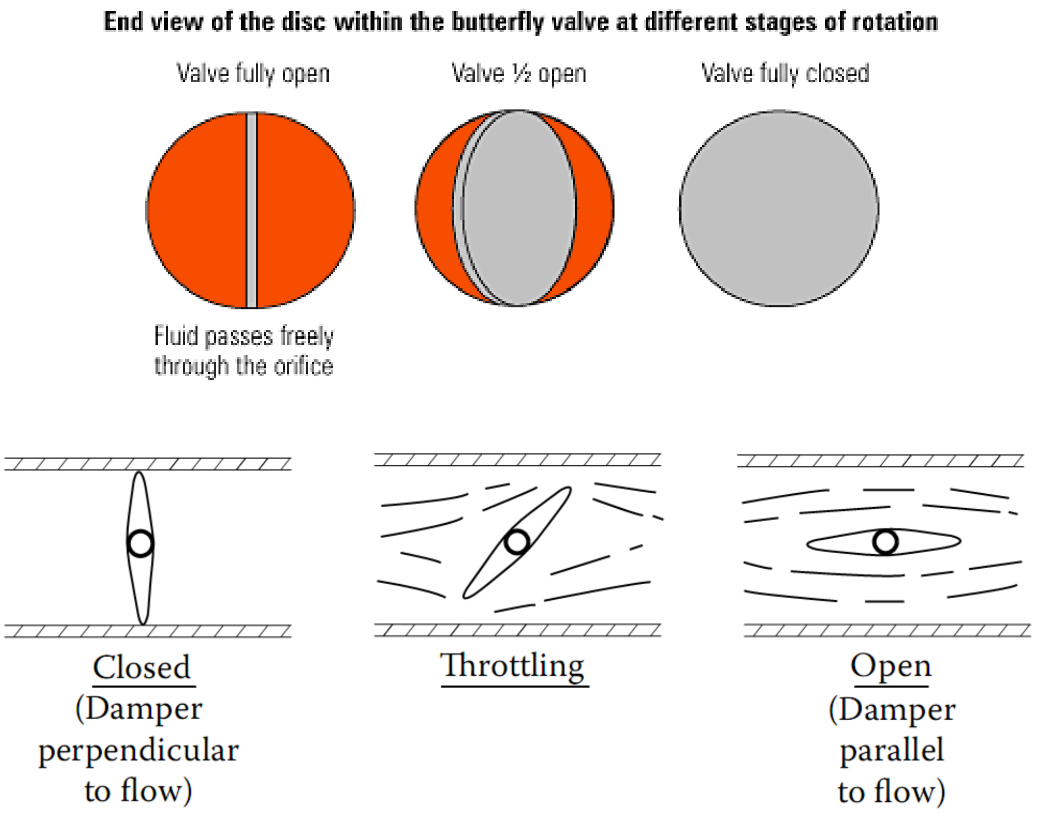


FIG. 6.17d

The vane positions of butterfly valve when closed, throttling, or open.

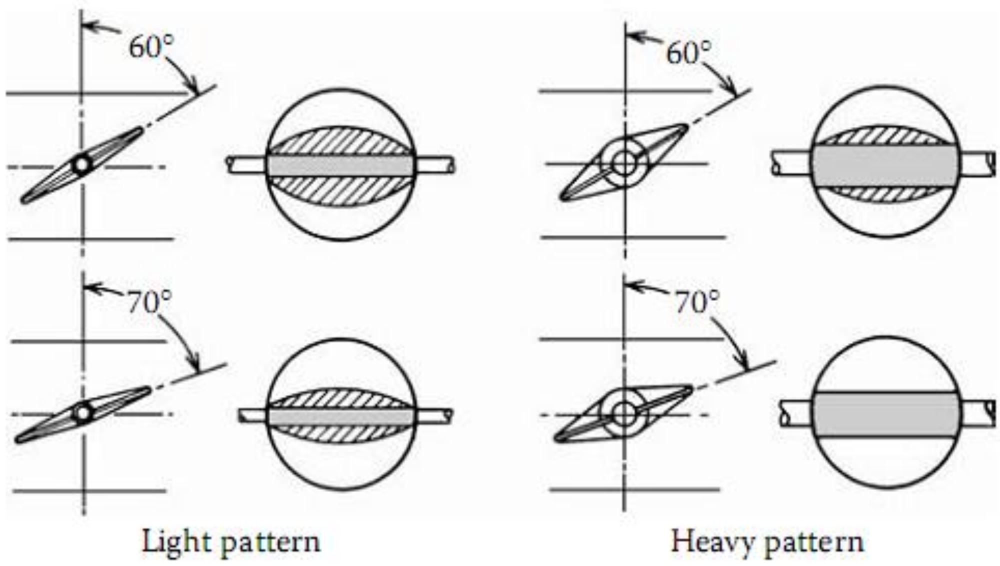


FIG. 6.17h

Effect of design pattern and shaft diameter on the flow area of butterfly valves.

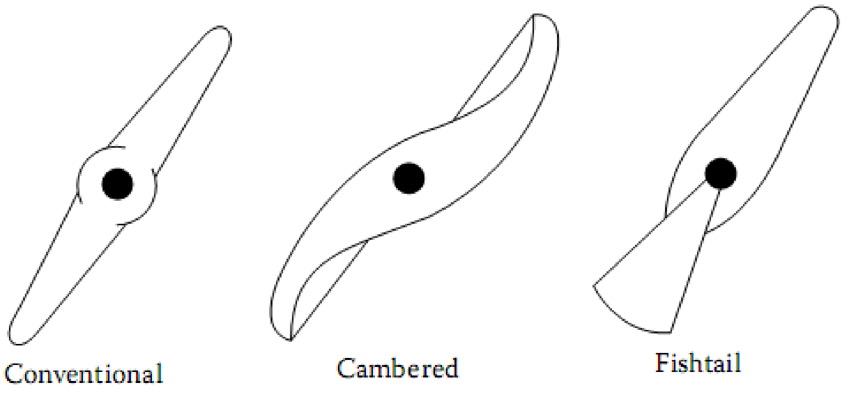


FIG. 6.17g
Cambered and fishtail disc shapes are used to reduce the required torque and to increase the throttling angle range.

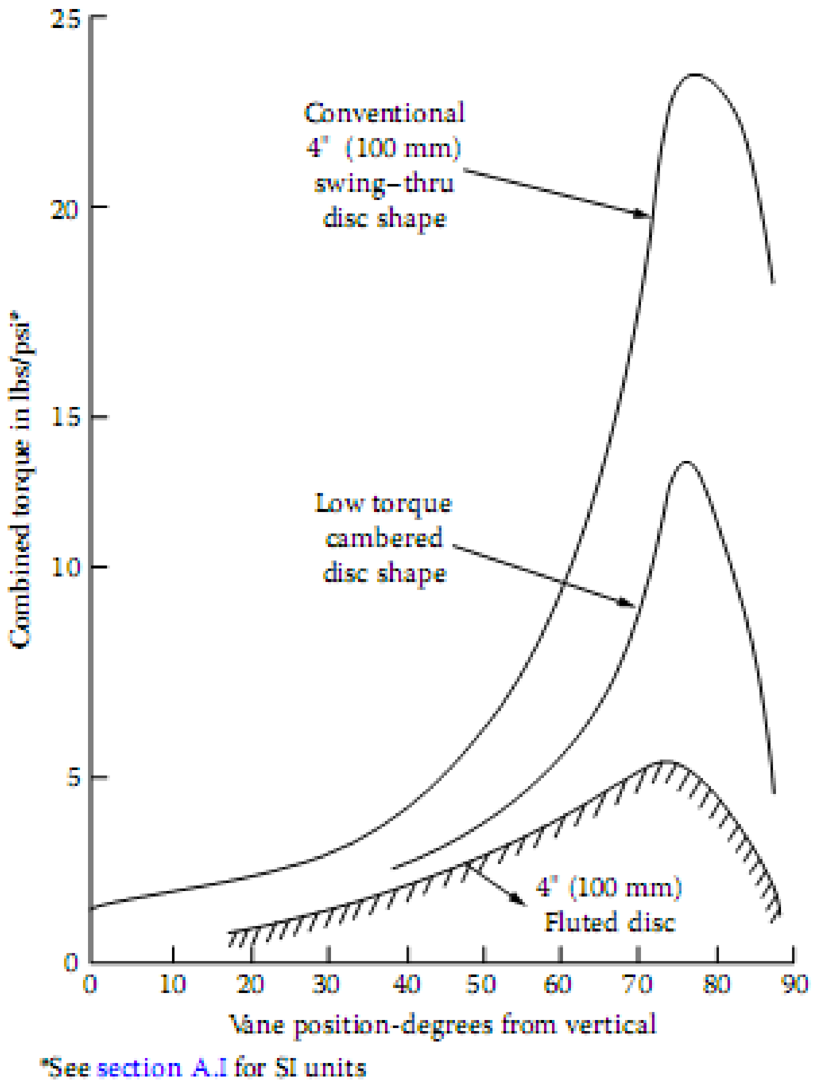


FIG. 6.17p
Combined torque requirements (sum of shaft friction and unbalanced torque) of a number of butterfly disc shapes at various degrees of rotation. (Courtesy of H. D. Baumann Co.)

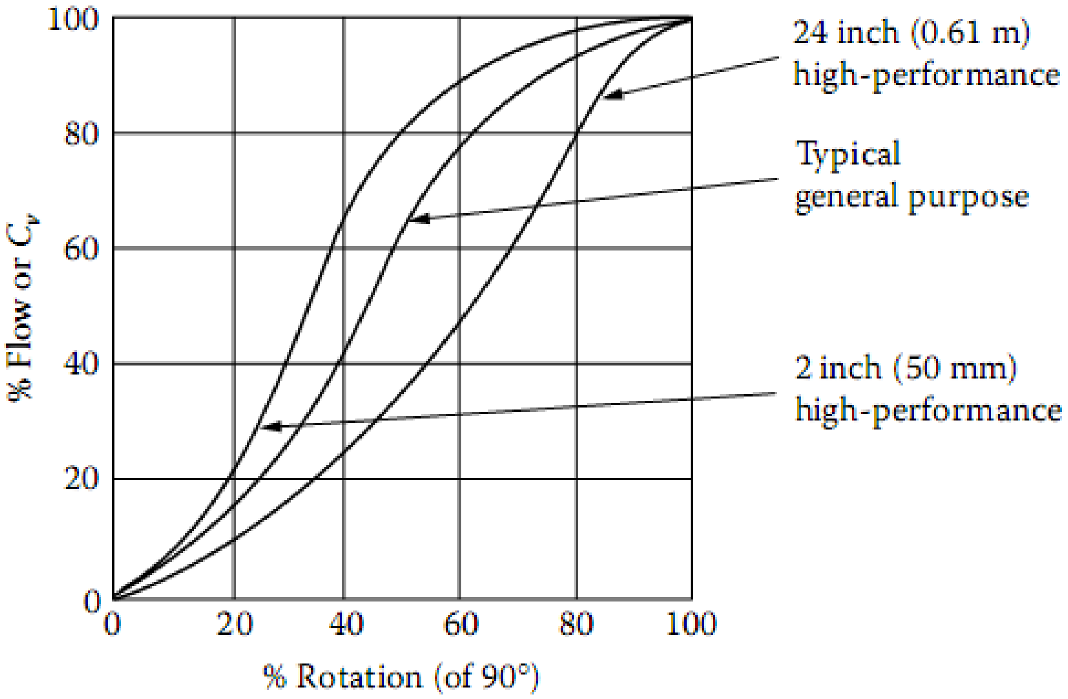
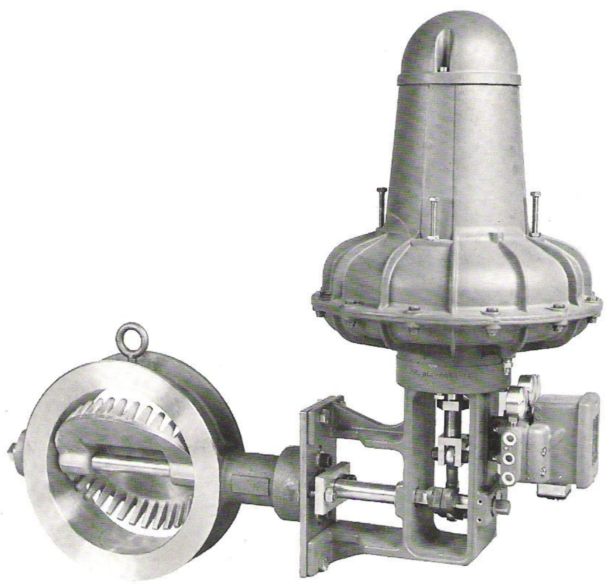
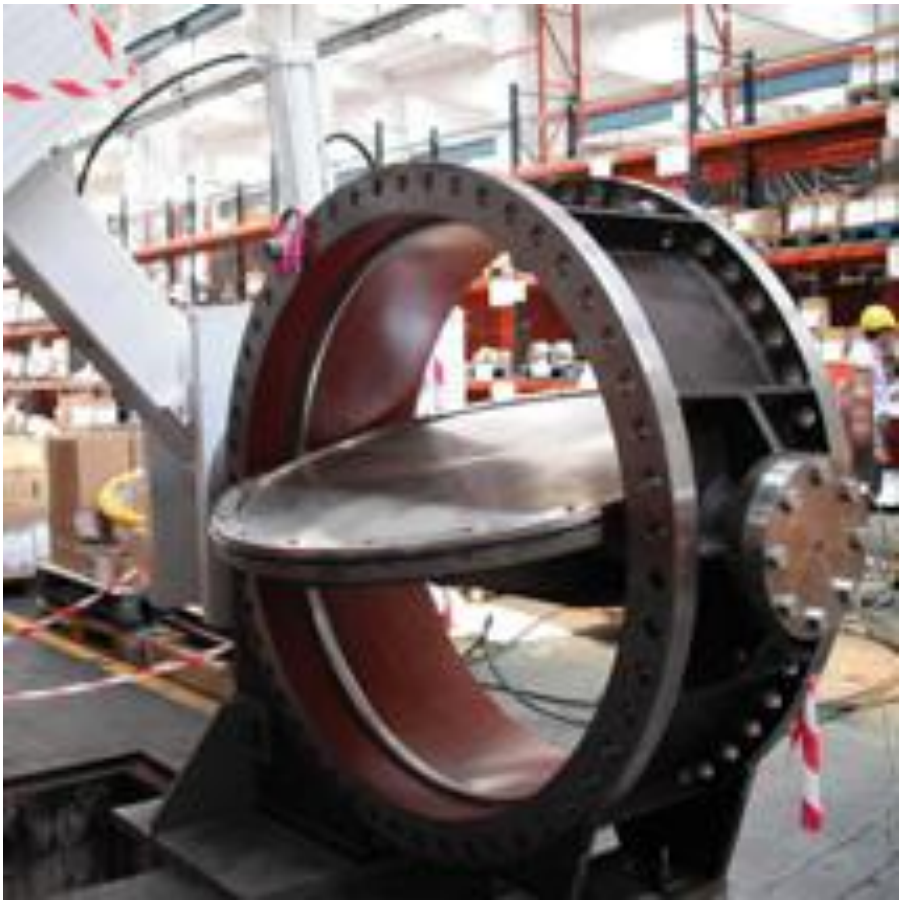


FIG. 6.17a
The flow characteristics of butterfly valves are affected by the location of the shaft (aligned or eccentric) and by the relative size of the shaft compared to the valve. The characteristics of high-performance designs are also slightly affected if the shaft is moved from the upstream to the downstream side of the disc. For throttling purposes the rotation of the valve is usually limited to move between the 0° and 60° positions.



Disco para evitar cavitación



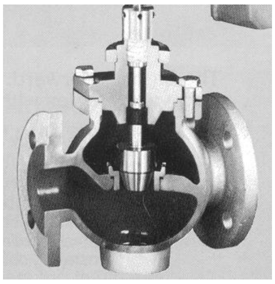
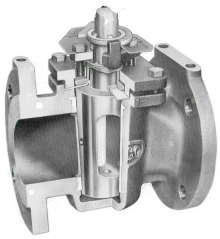
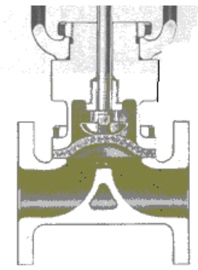
Tamaños especiales

¿QUÉ SIGNIFICA ESPECIFICAR UNA VÁLVULA DE CONTROL?

Significa determinar:

Cuerpo e internos (trim)	- Tipo (según el servicio) - Tamaño (diámetro) DIMENSIONAMIENTO - Material y serie - Característica de flujo
Actuador	- Tipo - Tamaño - Acción ante falla
Accesorios	- Límite de carrera - Conversores I/P o V/P - Volante para operación manual - Interruptores - Posicionador - Otros

CARACTERÍSTICAS DE LOS PRINCIPALES TIPOS DE VÁLVULAS DE CONTROL

TIPO	*CARACTERÍSTICA*
Globo 	• Alto costo en relación al Cv • Aplicación limitada para fluidos con partículas en suspensión • Diámetros hasta 24 pulgadas • Disponible en diversos modelos (simple y doble asiento, guiado en caja, etc.) • Existen tipos especiales para aplicaciones criogénicas, para vaporización, etc. • Rangeabilidad 35:1 a 50:1 • Amplia disponibilidad de características de flujo
Mariposa 	• Buena disponibilidad para grandes diámetros • Bajo costo en la versión estándar • Bajo costo en relación a Cv • Característica igual porcentaje salvo diseños especiales del plato • Susceptibles a cavitación y ruido • Baja pérdida de carga • Diámetros hasta 150 pulgadas • El cierre hermético requiere de recubrimientos especiales
Esférica (ball)  ***Tapon (plug)*** 	• Característica igual porcentaje salvo que el obturador tenga una sección especial • Apta para el manejo de suspensiones muy viscosas o con fibras y sólidos • Requiere motores de gran tamaño • Precisan posicionadores • Deben ser extraídas de la línea para mantenimiento • Rangeabilidad típica de 50:1
Sauders 	• Ampliamente usadas para el manejo de fluidos corrosivos o erosivos • Construcción simple • Cierre hermético y las partes móviles no tienen contacto con el fluido • Limitado rango para presiones y temperaturas de trabajo • Rangeabilidad entre 3:1 a 15:1

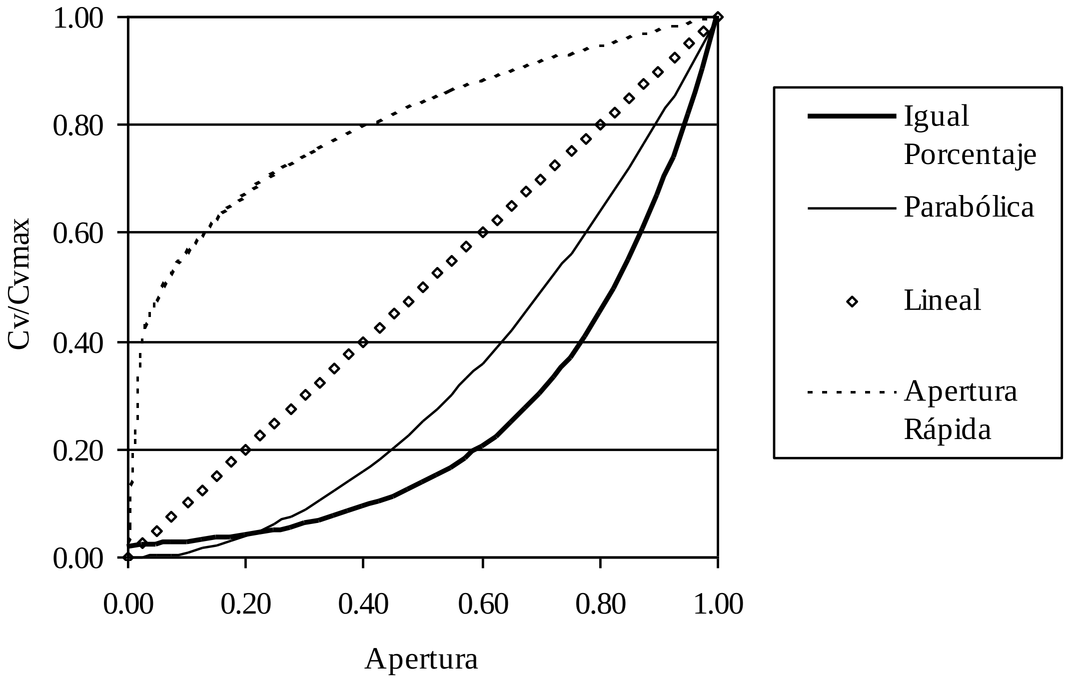
CARACTERÍSTICA DE FLUJO

La relación entre el flujo que pasa por una válvula y su apertura se denomina *Característica de Flujo*. Los fabricantes proveen lo que se denomina *Característica Inherente de Flujo*, que es la relación caudal apertura para pérdida de carga constante, que en definitiva es la relación de Cv con la apertura.

Esta es una propiedad intrínseca de la válvula. Existen Características Inherentes ampliamente difundidas entre los fabricantes.

Principales tipos de Características Inherentes

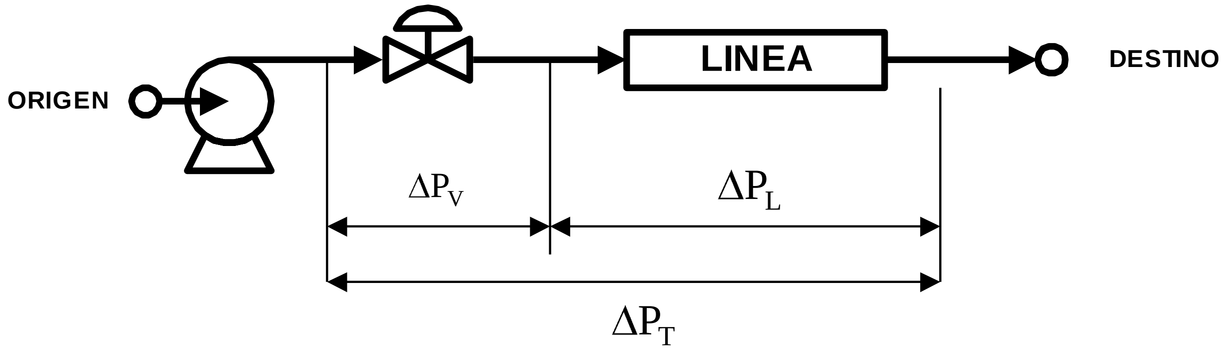
TIPO	**FORMULA TEORICA**
Igual porcentaje	$Cv(x) = Cv_{Min} \exp(a\,x)$ Cv_{Min}: coeficiente para x = 0 a: parámetro que depende de la amplitud de caudales que puede manejar la válvula
Parabólica	$Cv(x) = x^2\ Cv_{Max}$ Cv_{Max}: coeficiente para x = 1
Lineal	$Cv(x) = x\ Cv_{Max}$
Apertura rápida	No descripta por una fórmula de aceptación generalizada



Características Inherentes de flujo más difundidas

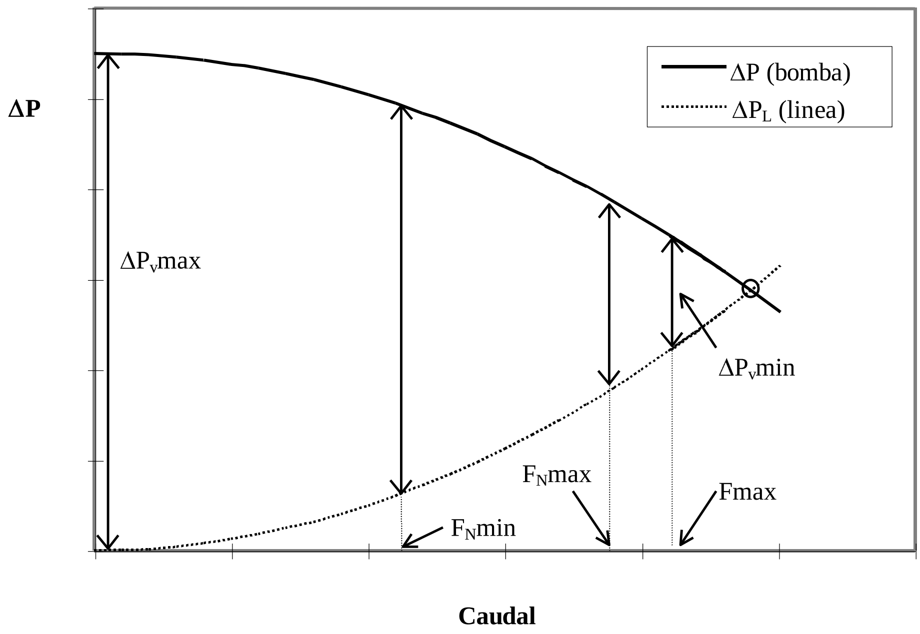
La *Característica de Flujo Instalada* es la relación flujo apertura de la válvula en la línea en las condiciones de trabajo. Cuando una válvula de control se instala en una planta de proceso, su característica de flujo depende de la Característica Inherente y del resto del sistema.

El flujo a través de la válvula está sujeto a resistencia por fricción en la propia válvula y en el resto de la línea como se muestra esquemáticamente en la Figura 3.



Esquema de una válvula instalada

Se puede apreciar cómo cambia la pérdida de carga en la válvula (ΔP_V) y la de la línea (ΔP_L) según el caudal que circula.



Relación entre diferencia de presiones y caudales en la línea

Para medir la influencia que ejerce la instalación en la característica de flujo de la válvula se define el coeficiente:

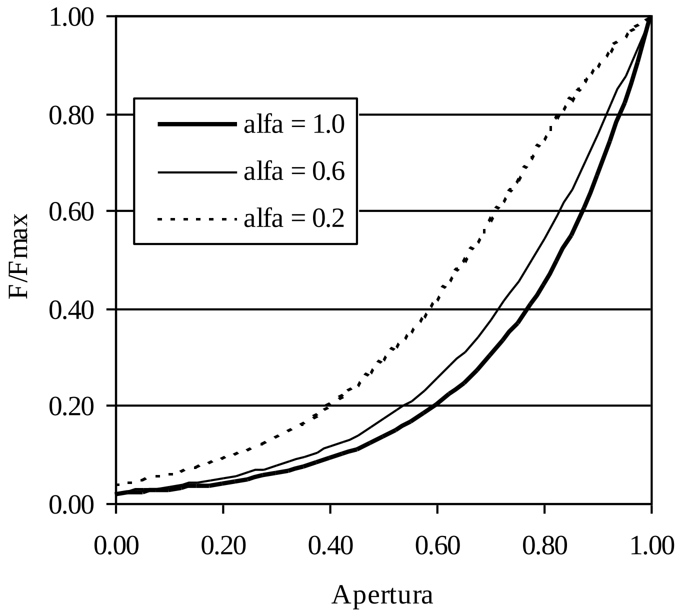
$$\alpha = \frac{\Delta P_V \text{ (válvula completamete abierta)}}{\Delta P_V \text{ (válvula en la menor apertura)}} = \frac{\Delta P_V \min}{\Delta P_V \max}$$

y como

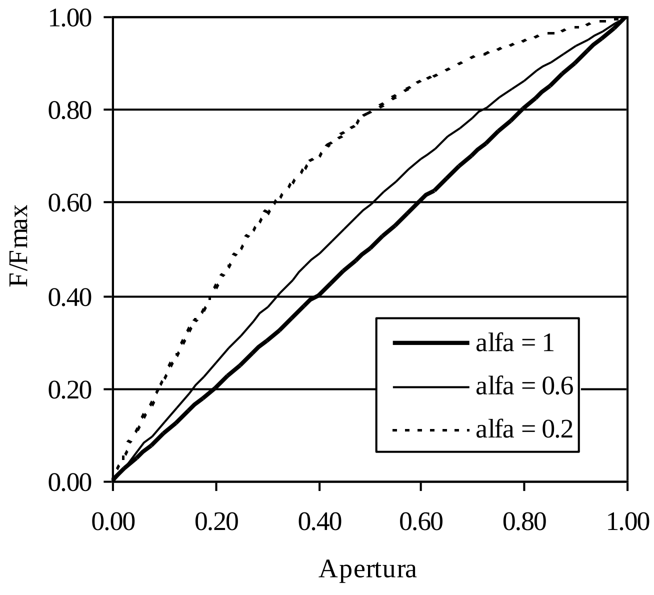
$$\Delta P_T = \Delta P_V + \Delta P_L = \Delta P_V \max$$

entonces α=1 significa que toda la pérdida de carga se concentra en la válvula independientemente del flujo que circule y por lo tanto la línea no tiene ninguna influencia en la característica de flujo. Valores decrecientes de α indicaran una creciente incidencia de la instalación.

En los gráficos se pone en evidencia que la instalación puede tener una influencia sustancial la característica de flujo instalada produciendo en algunos casos importantes distorsiones respecto de la inherente.



Distorsión de la característica de flujo por influencia de la instalación para una válvula de tipo igual porcentaje



Distorsión de la característica de flujo por influencia de la instalación para una válvula de tipo lineal

Valve Selection

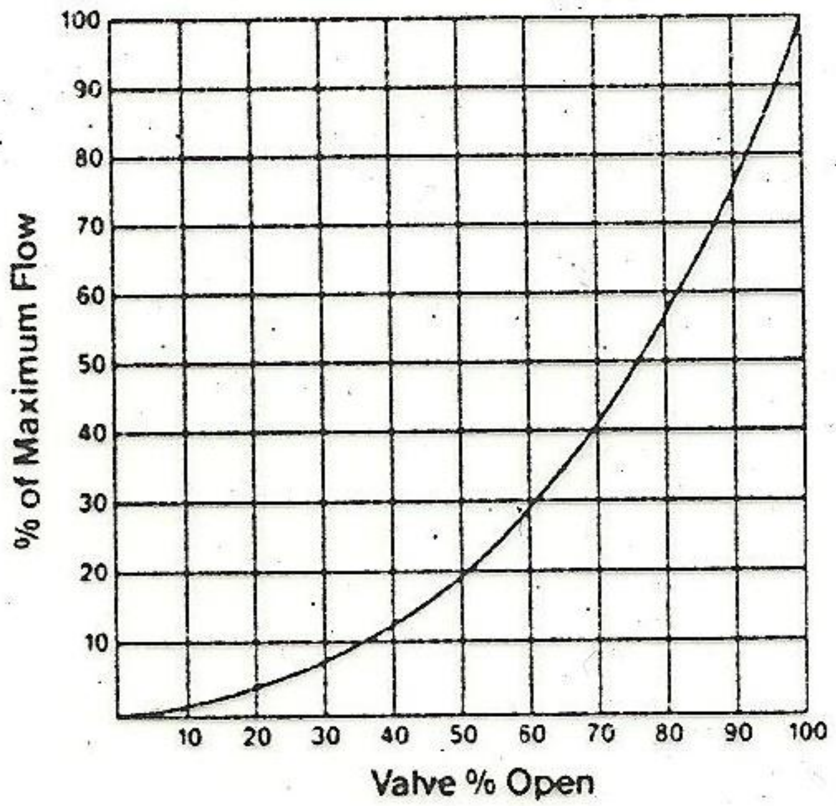
Cv Values

Standard Port

Valve Size (Inches)	% Open									
	100	90	80	70	60	50	40	30	20	10
1.5	25	19	14.6	10.3	7.2	4.8	3.1	1.9	0.7	0.1
2.0	90	20	53	37	26	17.3	11.2	6.8	2.6	0.5
2.5	145	112	85	60	42	28	18	10.9	4.2	0.7
3.0	245	190	145	101	71	47	30	18.4	7.1	1.2
4.0	360	279	210	150	104	69	45	27	10.4	1.8
5.0	550	425	325	230	159	105	68	41	16	2.8
6.0	1070	830	627	443	309	205	133	80	31	5.4
8.0	1500	1160	880	620	435	288	186	113	44	7.5
10.0	2750	2130	1610	1140	795	530	340	206	80	13.8
12.0	4400	3410	2580	1820	1270	845	545	330	128	22
14.0	6450	5000	3780	2670	1865	1240	800	484	187	32
16.0	9000	6975	5275	3725	2600	1730	1115	675	260	45
18.0	12000	9300	7030	4970	3470	2305	1490	900	350	60
20.0	15200	11800	8905	6295	4395	2920	1885	1140	440	76

Note: Flow in GPM of water at 1 psi pressure drop and at 60°F.

Flow Characteristic



GUÍA PARA LA SELECCIÓN DEL TIPO POR SERVICIO

Features & Applications	*Ball: Conventional*	*Ball: Characterized*	*Butterfly: Conventional*	*Butterfly: High-performance*	*Digital*	*Globe: Single-ported*	*Globe: Double-ported*
Features:							
ANSI class pressure rating (max.)	2500	600	300	600	2500	2500	2500
Max. capacity (C_d)	45	25	40	25	14	12	15
Characteristics	F	G	P	F, G	E	E	E
Corrosive Service	E	E	G	G	F, G	G, E	G, E
Cost (relative to single-port globe)	0.7	0.9	0.6	0.9	3.0	1.0	1.2
Cryogenic service	A	S	A	A	A	A	A
High pressure drop (over 200 PSI)	A	A	NA	A	E	G	G
High temperature (over 500°F)	Y	S	E	G	Y	Y	Y
Leakage (ANSI class)	V	IV	I	IV	V	IV	II
Liquids:							
Abrasive service	C	C	NA	NA	P	G	G
Cavitation resistance	L	L	L	L	M	H	H
Dirty service	G	G	F	G	NA	F, G	F
Flashing applications	P	P	P	F	F	G	G
Slurry including fibrous service	G	G	F	F	NA	F, G	F, G
Viscous service	G	G	G	G	F	G	F, G
Gas/Vapor:							
Abrasive, erosive	C	C	F	F	P	G	G
Dirty	G	G	G	G	NA	G	F, G

Abbreviations:

A = Available
C = All-ceramic design available
F = Fair
G = Good
E = Excellent
H = High

L = Low
M = Medium
NA = Not available
P = Poor
S = Special designs only
Y = Yes

Features & Applications	*Globe: Angle*	*Globe: Eccentric disc*	*Pinch*	*Plug: Conventional*	*Plug: Characterized*	*Saunders*
Features:						
ANSI class pressure rating (max.)	2500	600	150	2500	300	150
Max. capacity (C_d)	12	13	60	35	25	20
Characteristics	E	G	P	P	F, G	P, F
Corrosive Service	G, E	F, G	G	G, E	G	G
Cost (relative to single-port globe)	1.1	1.0	0.5	0.7	0.9	0.6
Cryogenic service	A	A	NA	A	S	NA
High pressure drop (over 200 PSI)	E	A	NA	A	A	NA
High temperature (over 500°F)	Y	Y	NA	S	S	NA
Leakage (ANSI class)	IV	IV	IV	IV	IV	V
Liquids:						
Abrasive service	E	G	G, E	F, G	F, G	F, G
Cavitation resistance	H	M	NA	L	L	NA
Dirty service	G	F, G	E	G	G	G, E
Flashing applications	E	G	F	P	P	F
Slurry including fibrous service	G, E	F, G	E	G	G	E
Viscous service	G, E	F, G	G, E	G	G	G, E
Gas/Vapor:						
Abrasive, erosive	E	F, G	G, E	F, G	F, G	G
Dirty	G	F, G	G	G	G	G

Abbreviations:

A = Available
C = All-ceramic design available
F = Fair
G = Good
E = Excellent
H = High

L = Low
M = Medium
NA = Not available
P = Poor
S = Special designs only
Y = Yes

Features & Applications	*Saunders*	*Sliding gate: V-Insert*	*gate: Positioned disc*	*Special: Dynamically balanced*
Features: ANSI class pressure rating (max.)	150	150	2500	1500
Max. capacity (C_d)	20	30	10	30
Characteristics	P, F	F	F	F, G
Corrosive Service	G	F, G	G	G, E
Cost (relative to single-port globe)	0.6	1.0	2.0	1.5
Cryogenic service	NA	A	NA	NA
High pressure drop (over 200 PSI)	NA	NA	E	E
High temperature (over 500°F)	NA	NA	S	NA
Leakage (ANSI class)	V	I	IV	II
Liquids: Abrasive service	F, G	NA	E	G
Cavitation resistance	NA	L	H	M
Dirty service	G, E	G	F	F
Flashing applications	F	P	G	P
Slurry including fibrous service	E	G	P	F
Viscous service	G, E	F	F	F
Gas/Vapor: Abrasive, erosive	G	NA	E	E
Dirty	G	G	F	G

Abbreviations:

A = Available
C = All-ceramic design available
F = Fair
G = Good
E = Excellent
H = High

L = Low
M = Medium
NA = Not available
P = Poor
S = Special designs only
Y = Yes

Table 1. Find candidate valves by considering general features of each type.					
	Type of Valve				
	Gate	Plug (Ball)	Globe	Butterfly	Diaphragm
Type of Service	On/off (Sliding)	On/off (Rotary)	Throttling	Throttling	Throttling
Advantages	Virtually no pressure loss across the valve face Can be used when the fluid contains suspended solids	Similar properties to gate valves Lightweight, compact design High capacity Good rangeability Tight shut-off	Good sealing characteristics Can be used in frequent open/ closing service Quick change of trim without removing valve from line High capacity God rangeability Low-noise trim available Smooth control	Lightweight, compact design Minimal pressure loss across valve face Low cost High throughput capacity Smaller shaft and actuator	Almost no leakage; process fluid is isolated from valve stem Self-cleaning
Disadvantages	Poor sealing characteristics	Sealability poor with metal seats used at high temperatures Limited-temperature range with resilient seats Choke flow problems Cavitation problems Requires removal for maintenance	High-pressure losses due to contorted path through the valve Low-noise trim reduces capacity	Poor sealing characteristics Good control limited to 60-deg. opening Tight shut-off requires special lining: plus over-sized shaft and actuators Lining imposes temperature limitations	Limited operating pressure Limited temperature High wear and tear Poor control over 50%-opening
Sealing Method	Gate face slides parallel to the seal surface. Gate and seal in constant shear contact	Radial seal, shaped to conform with ball surface	Disk motion is perpendicular to valve seat. Only contact is in fully closed position	Throttle blade is mashed into mated seal	Diaphragm material is forced onto valve seat. Only contact is in fully closed position
Recommendations	Not for frequent valve opening/ closing service Not for when throttling control is required	Not for service with highly corrosive fluids Most suitable for handling slurries	For flow regulation When tight shut-off is required	Low-pressure applications	Water-treatment service Chemical and abrasive service

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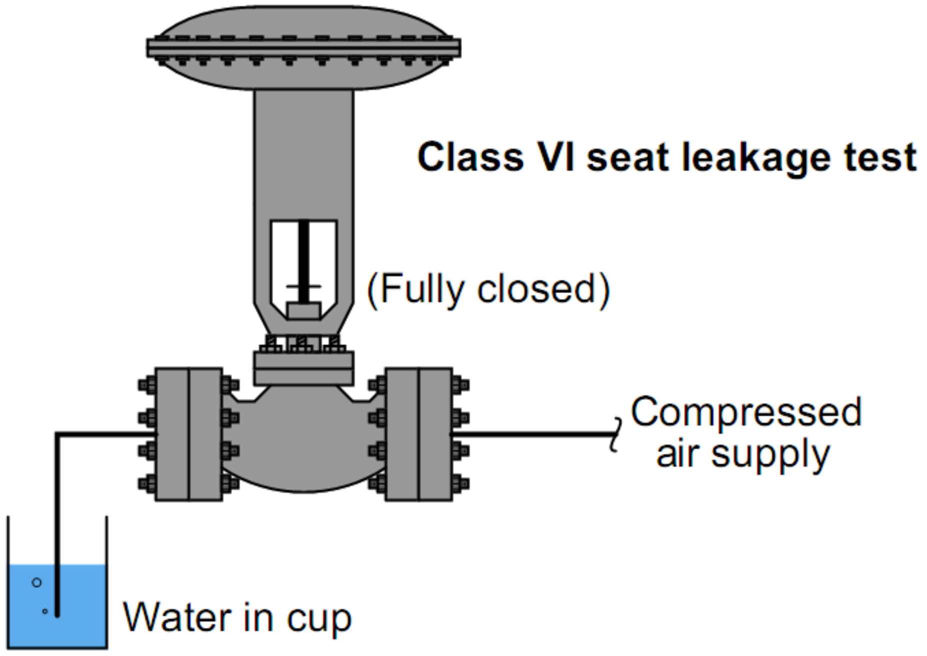
DeZURIK Valve Selection Chart

1 = Typical Application 2 = May Be Used 3 = Limited Application 4 = Not Used

Application Requirements	Butterfly Valves			Plug Valves			Gate Valves		Rotary Control Valves	
	AWWA	Resilient Seated	High Performance	Standard Port Eccentric	100% Port Eccentric	3-Way & 4-Way	Knife Gate	Ported Gate	Rotary Control Valves	V-Port Control Valve
Function:										
On-Off	1	1	1	1	1	4	1	1	1	2
Throttling	1	1	1	1	1	1	3	4	1	1
Diversion	3	3	3	4	4	1	4	4	4	4
Media:										
Liquids (Clean)	1	1	1	1	1	1	1	3	1	1
Liquids (Dirty)	2	2	3	1	1	1	1	1	1	1
Liquids (Viscous)	2	1	2	1	1	1	1	1	1	1
Liquids (Corrosive)	4	2	1	1	1	1	2	1	1	1
Slurries (Sludge)	2	2	3	1	1	1	1	1	1	1
Liquids & Slurries (Scaling)	4	4	4	2	2	4	4	1	2	3
Slurries (Abrasive)	4	3	2	2	2	2	1	1	1	3
Slurries (Fibrous)	4	2	2	2	2	1	1	1	4	1
High Pressure Steam (+150lbs.)	4	4	1	4	4	4	4	4	1	3
Low Pressure Steam	4	4	1	3	4	3	4	3	1	1
Gasses (Clean)	1	1	1	1	1	1	2	2	1	1
Gasses (Dirty)	2	2	3	1	1	1	2	2	1	1
Gasses (Corrosive)	4	2	1	1	1	1	2	2	1	1
Dry Materials	4	2	4	2	2	4	1	1	4	4
Valve Characteristics:										
High Flow Capacity	1	1	1	2	1	1	1	1	1	1
Low Head Loss (Wide Open)	1	1	1	2	1	1	1	1	N/A	1
Low Torque/Thrust	2	2	1	2	2	1	2	2	2	1
High Temp., 800°F+ (425°C+)	4	4	3	3	4	4	1	4	3	4
Cryogenic	4	4	3	4	4	4	4	4	2	4
Erosion Resistance	4	3	2	1	1	3	1	1	1	3
Cavitation (Kc) @ 60% Open	.35	.35	.35	.59	.59	N/A	N/A	N/A	.60	.49
Recovery Factor F_L^2 @ 60% Open	.40	.40	.43	.70	.70	N/A	N/A	N/A	.70	.61

CAUDAL DE FUGA



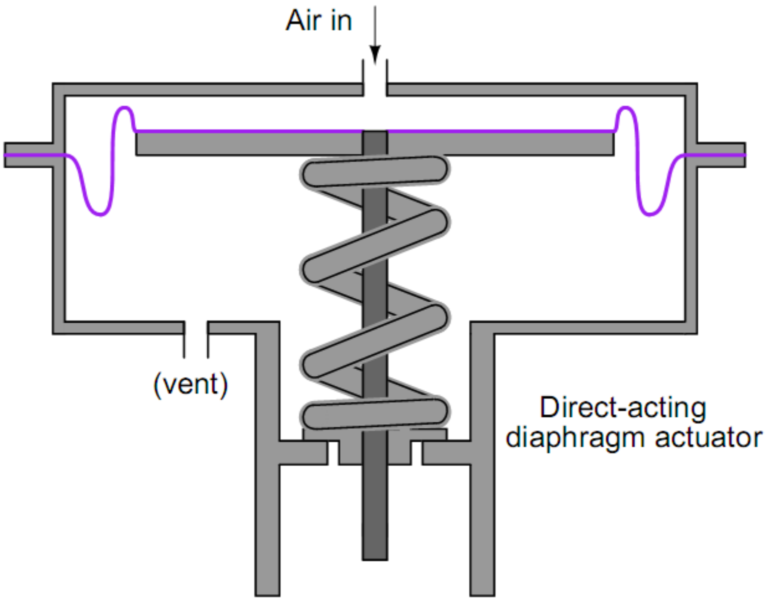
Class	Maximum allowable leakage rate	Test pressure drop
I	(no specification given)	(no specification given)
II	0.5% of rated flow capacity, air or water	45-60 PSI or max. operating
III	0.1% of rated flow capacity, air or water	45-60 PSI or max. operating
IV	0.01% of rated flow capacity, air or water	45-60 PSI or max. operating
V	0.0005 ml/min water per inch orifice size per PSI	Max. operating
VI	Bubble test, air or nitrogen	50 PSI or max. operating

ACTUADORES DE VÁLVULAS DE CONTROL

El actuador de una válvula proporciona la fuerza motriz necesaria para el movimiento del vástago siguiendo una señal de control (neumática, eléctrica, hidráulica).

- **Actuador neumático de cabezal**
- **Actuador neumático de pistón**
- **Actuador eléctrico**
- **Actuador hidráulico**

ACTUADOR NEUMÁTICO DE CABEZAL

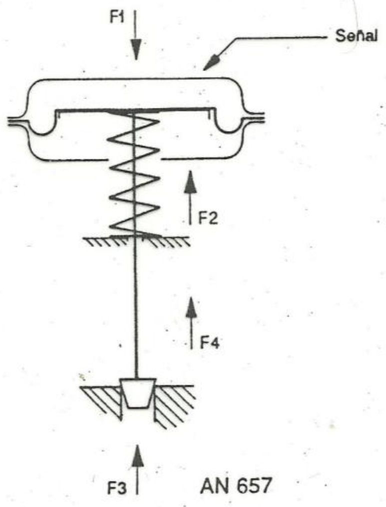


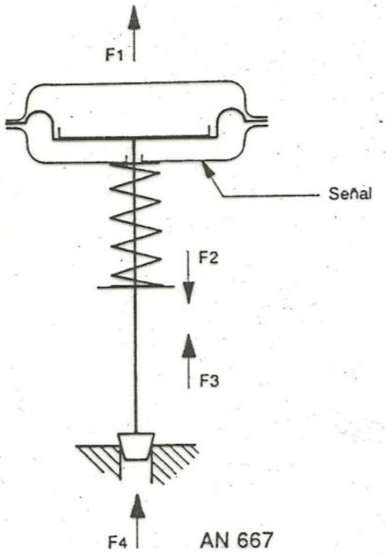
BALANCE DE FUERZAS Y DIMENSIONAMIENTO

ECUACION DE FUERZAS EN ACTUADORES TIPO AN 657

$$\boxed{F1 = F2 + F3 + F4}$$

F1 = Area efectiva mínima del actuador (ver tabla Nº 1) x señal máxima del rango del actuador.
F2 = Fuerza de compresión del resorte. Ejemplo: si el resorte es de 3-9 PSI, F2 = 9 PSI x área efectiva mínima (de tabla Nº 1).
F3 = Fuerza de desbalance = área de desbalance x Δp máximo (en cuerpos balanceados tomar área de desbalance de tabla Nº 4).
F4 = Fuerza efectiva de cierre (carga de cierre x circunsferencia del asiento según carga de cierre y tabla Nº 4) + carga obsorbida por la empaquetadura (tabla Nº 3).





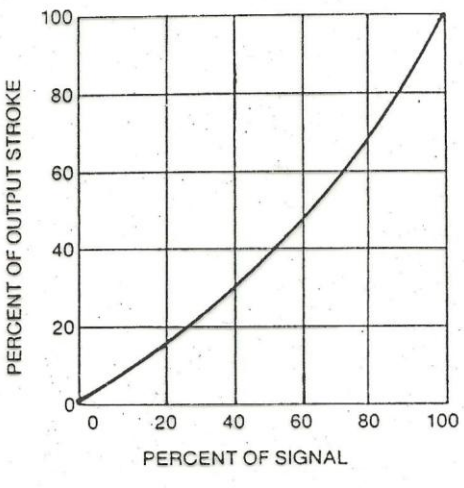
ECUACION DE FUERZAS EN ACTUADORES TIPO AN 667

En todo momento se cumple
$$\boxed{F1 + F3 + F4 = F2}$$

F1 = Area efectiva máxima del actuador (ver tabla Nº 1) x señal mínima del rango del actuador.
F2 = Fuerza de compresión del resorte. Ejemplo: si el resorte es de 9-15 PSI, F2 = 9 PSI x área efectiva máxima (de tabla Nº 1).
F3 = Fuerza de desbalance = área de desbalance x Δp máximo (en cuerpos balanceados tomar área de desbalance de tabla Nº 4).
F4 = Fuerza efectiva de cierre (carga de cierre x circunsferencia del asiento según carga de cierre y tabla Nº 4) + carga obsorbida por la empaquetadura (tabla Nº 3).

NOTA: Tenga en cuenta utilizar el mismo sistema de unidades en los cálculos.

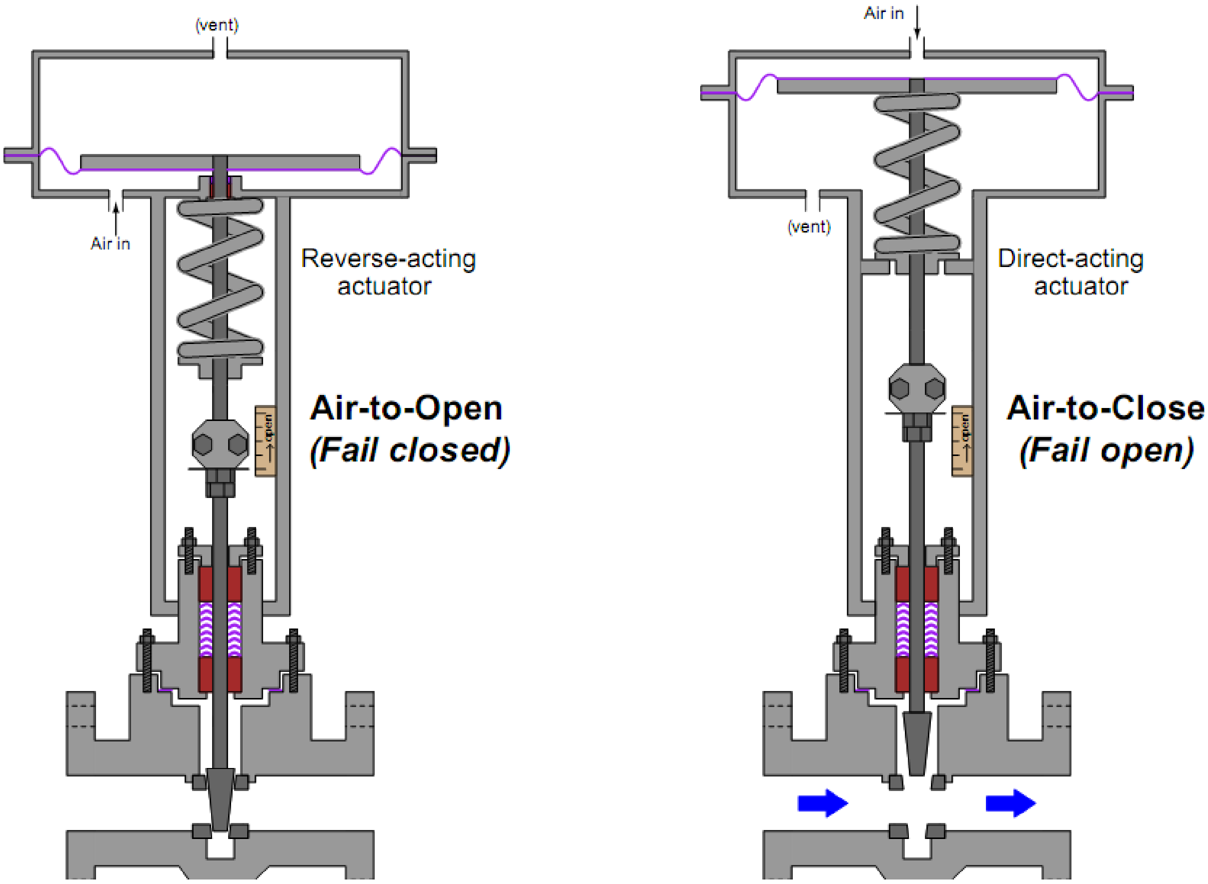
output stroke characterization



Se selecciona el tamaño del actuador en base a la presión de suministro del aire, y la fuerza efectiva de cierre.

Depende de cada fabricante como se codifica la selección del tamaño.

ACCION DE VÁLVULAS Y ACTUADORES



Valve failure (Overall)	*Fail Open*		*Fail Closed*	
Actuator	Direct	Reverse	Reverse	Direct
Inner Valve	Direct	Reverse	Direct	Reverse

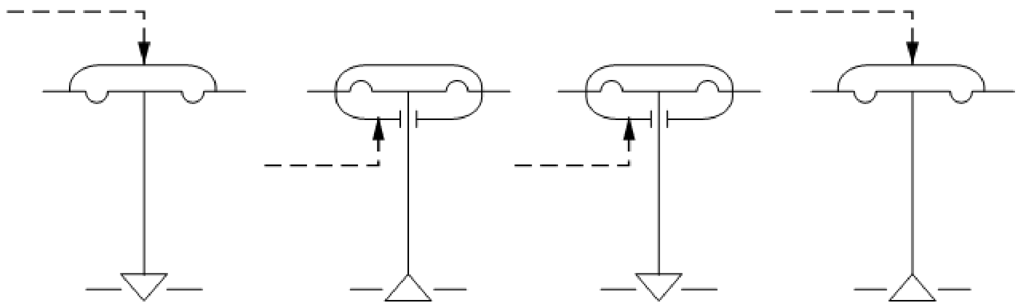
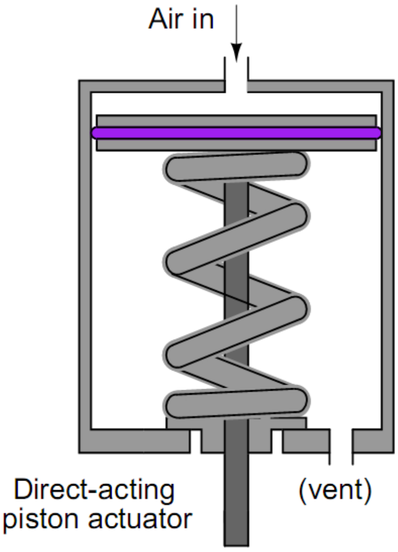
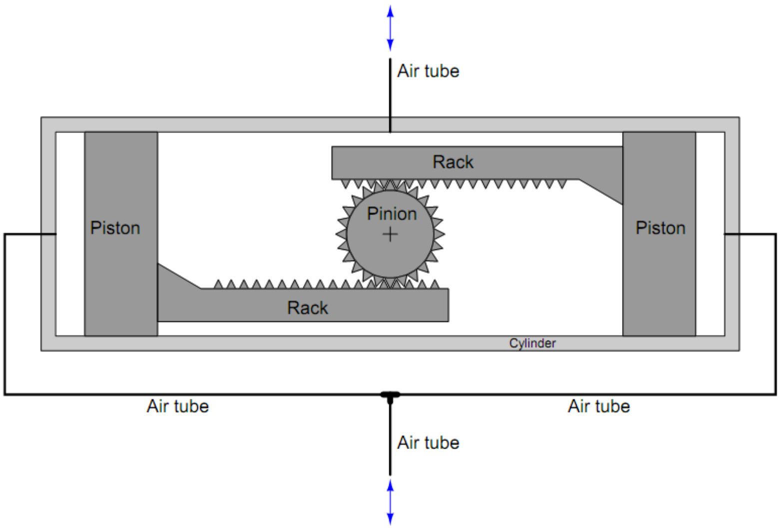


FIG. 6.4k

Overall valve failure positions, which can be achieved by various combinations of direct or reverse actuators and inner valves.

PISTÓN NEUMÁTICO





ACTUADORES HIDRÁULICOS

ACTUADORES ELECTROMECÁNICOS

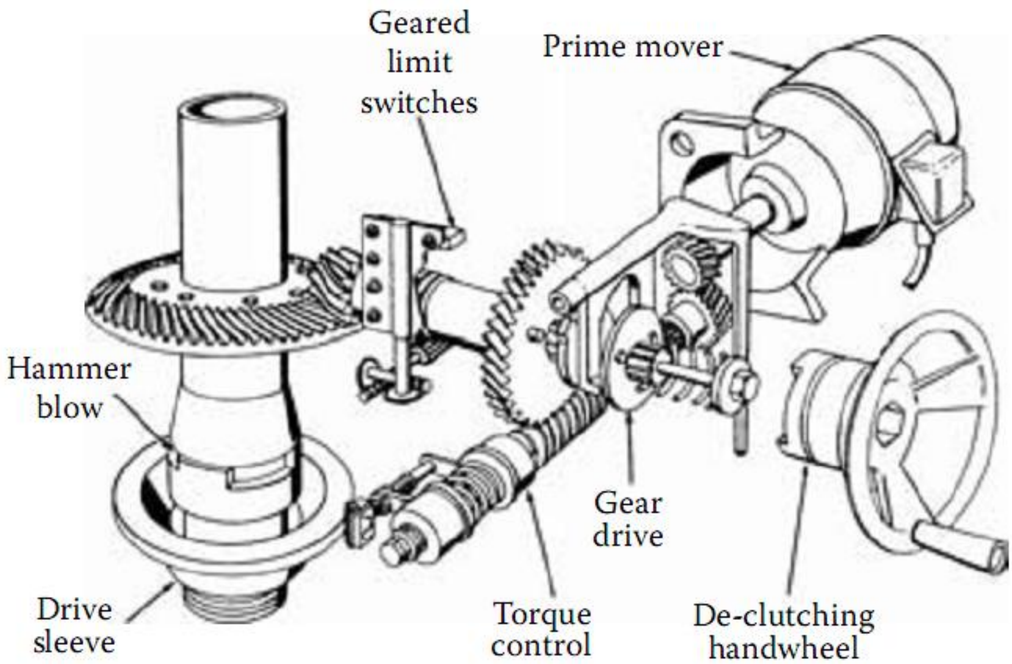
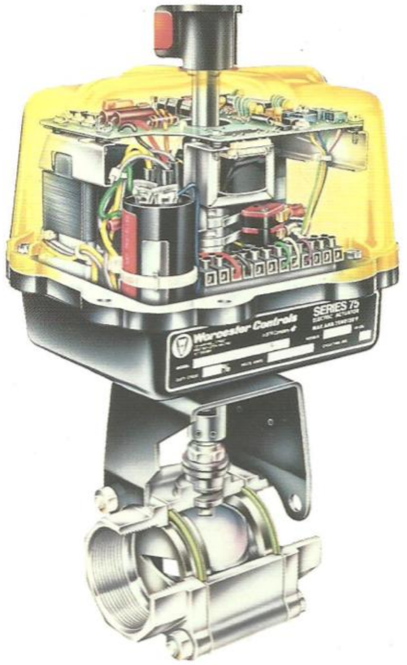


FIG. 6.3e
Electric actuator with worm gear reduction.

MOTORES ELÉCTRICOS

Automation & Throttling Control



Control Valve Packages

What you need from an automation package is complete reliability. An inferior control valve package is an invitation to costly downtime and expensive maintenance complications.

Throttling Electronic/Computer Control

The ultimate actuator valve package for electronic process control includes the Series 75 electric actuator, with an HQ99 electronic set-point controller, and a characterized metal seat for precise control.

The CPT characterized seat, Worcester's patented metal seat technology, allows high pressure drops, high rangeability, and controllable low and high flow control - C_Vs from .07 to 380. The seats come in standard slots, or can be custom designed to suit your process needs. Bulletin #PB-V.

The AF17 solid state positioner throttles AC or DC electric actuators for the highest possible accuracy of control. It is designed for harsh environments and demanding industrial applications offering high resolution and easy adjustments. Bulletin #AF 101.

The HQ99 solid state set point controller/positioner is designed to position the actuator of the valve, damper or any other device accurately to meet the process set point without overshooting. The variable speed adjustment of the HQ99 prevents hunting and is an excellent feature for applications such as temperature control where speed of response adjustment is a must. Bulletin #PB-HQ.

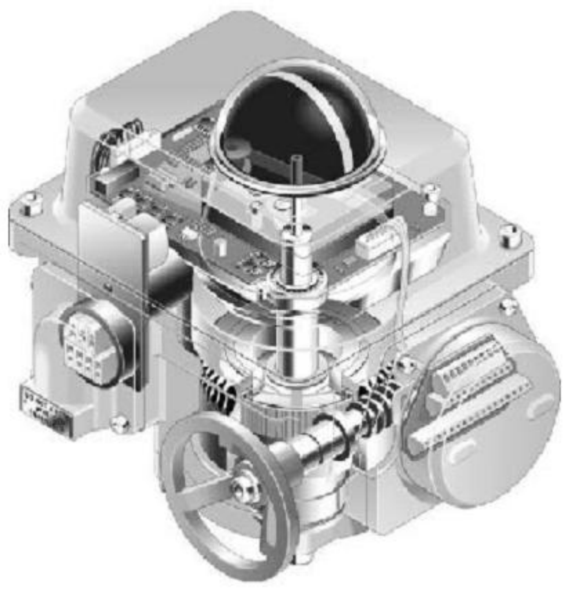
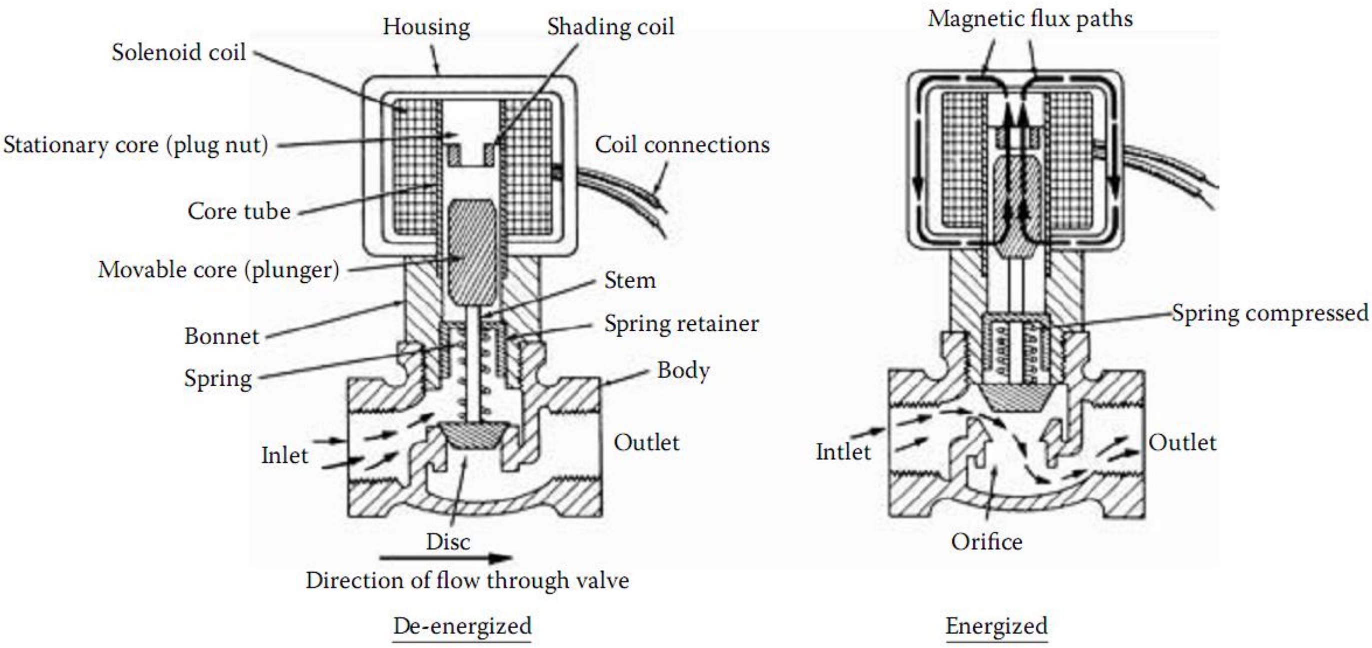


FIGURE 37 Technical improvements have made electric actuators practicable for control purposes. They offer high thrust or torque and high stiffness. (*El-O-Matic International.*)

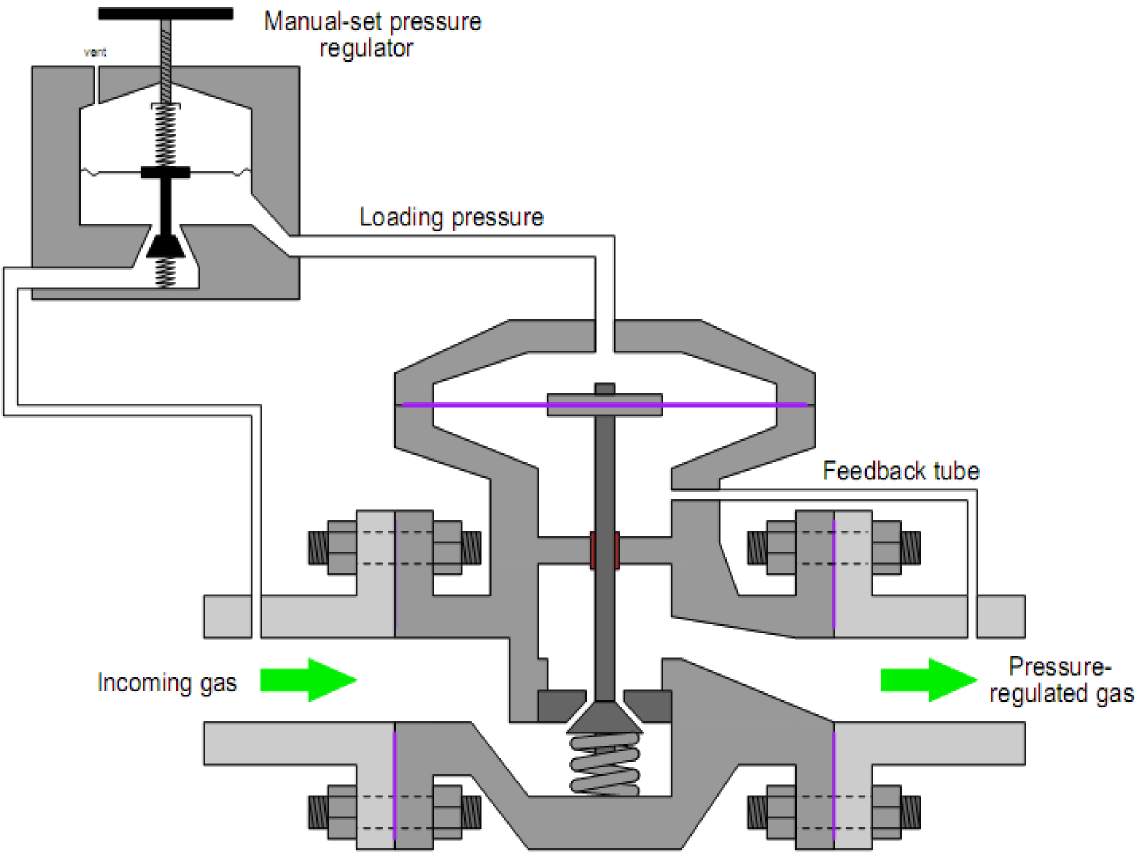
COMPARACIÓN DE ACTUADORES

Advantages	Disadvantages
Spring and diaphragm	
Lowest cost Ability to throttle without positioner Simplicity Inherent failure-mode action Low supply-pressure requirement Adjustability to varying conditions Ease of maintenance	Limited output capability Large size and weight
High-pressure spring and diaphragm	
Compact, light weight No spring adjustment needed Costly cast components not needed Inherent fall-safe action No dynamic stem seals or traditional stem connector block needed Design can include integral accessories	Requires high supply pressure—40 psig (2.8 bars) or higher Positioner required for throttling
Pneumatic piston	
High force or torque capability Compact, light weight Adaptable to high ambient temperatures Fast stroking speed Relatively high actuator stiffness	Fall-safe requires accessories or addition of a spring Positioner required for throttling Higher cost High supply-pressure requirement
Electric motor	
Compact Very high stiffness High output capability Supply pressure piping not required	High cost Lack of fail-safe action Limited duty cycle Slow stroking speed
Electrohydraulic	
High output capability High actuator stiffness Excellent throtting ability Fast stroking speed	High cost Complexity and maintenance difficulty Fail-safe action only with accessories

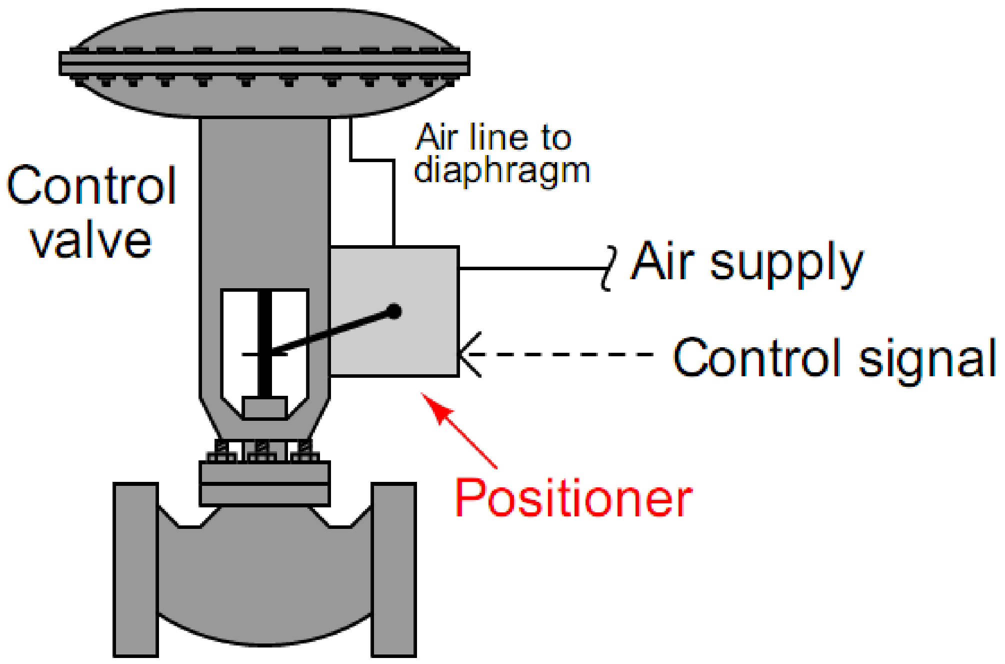
VÁLVULAS SOLENOIDES

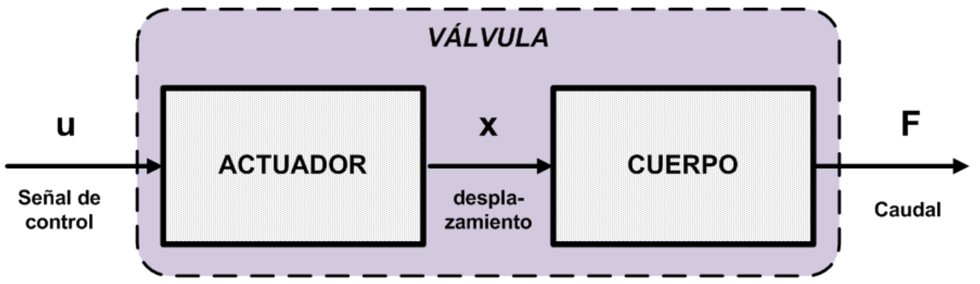


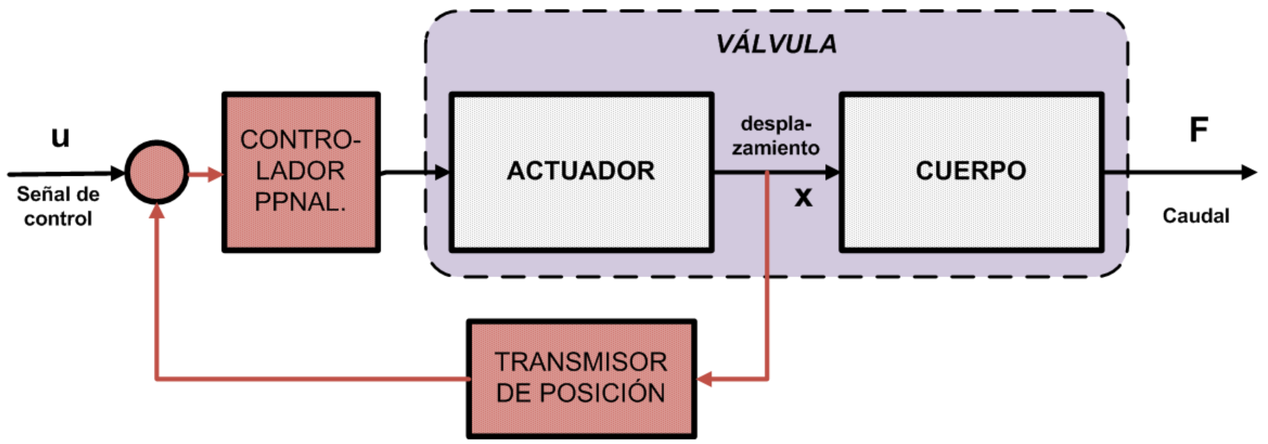
VÁLVULAS AUTOREGULADORAS

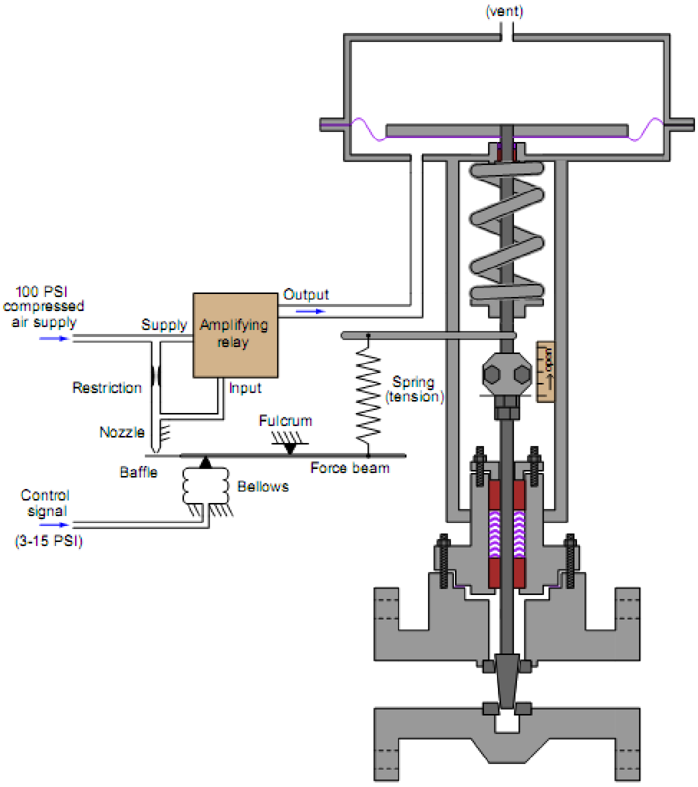


POSICIONADOR DE VÁLVULA









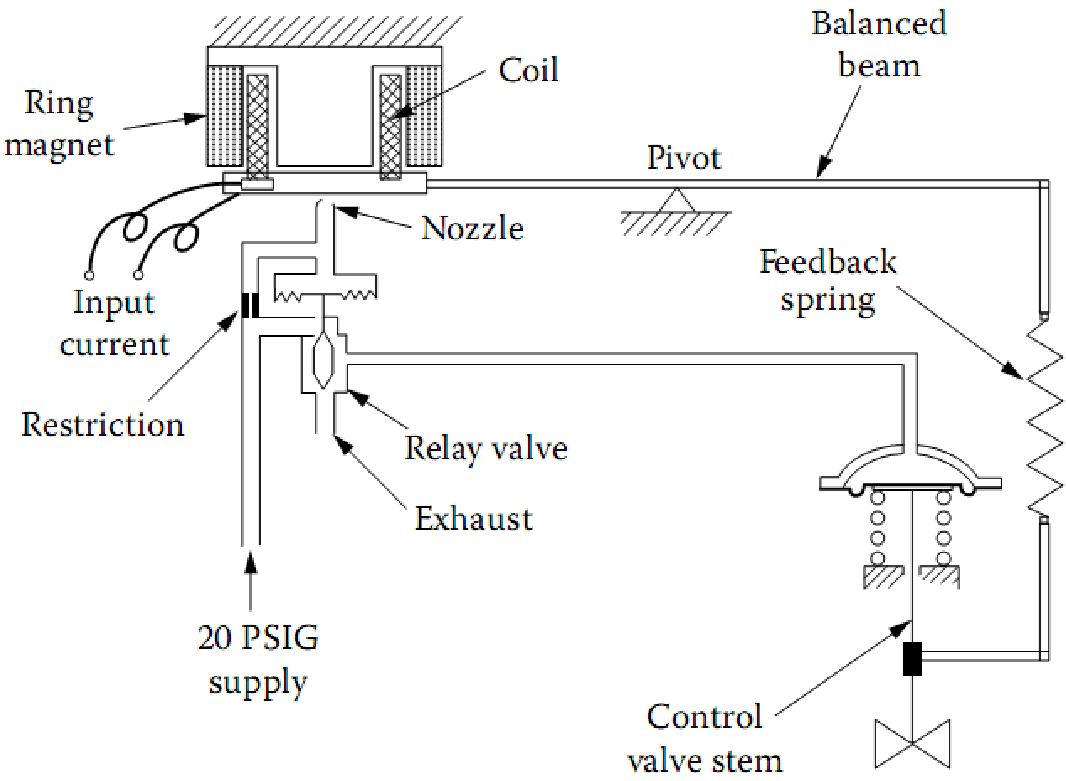
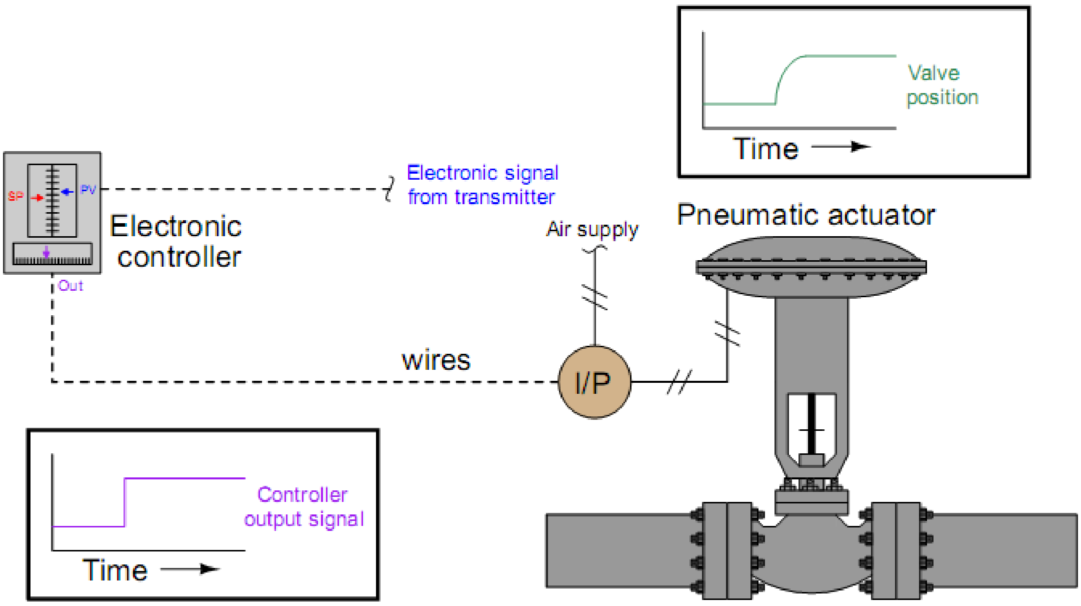


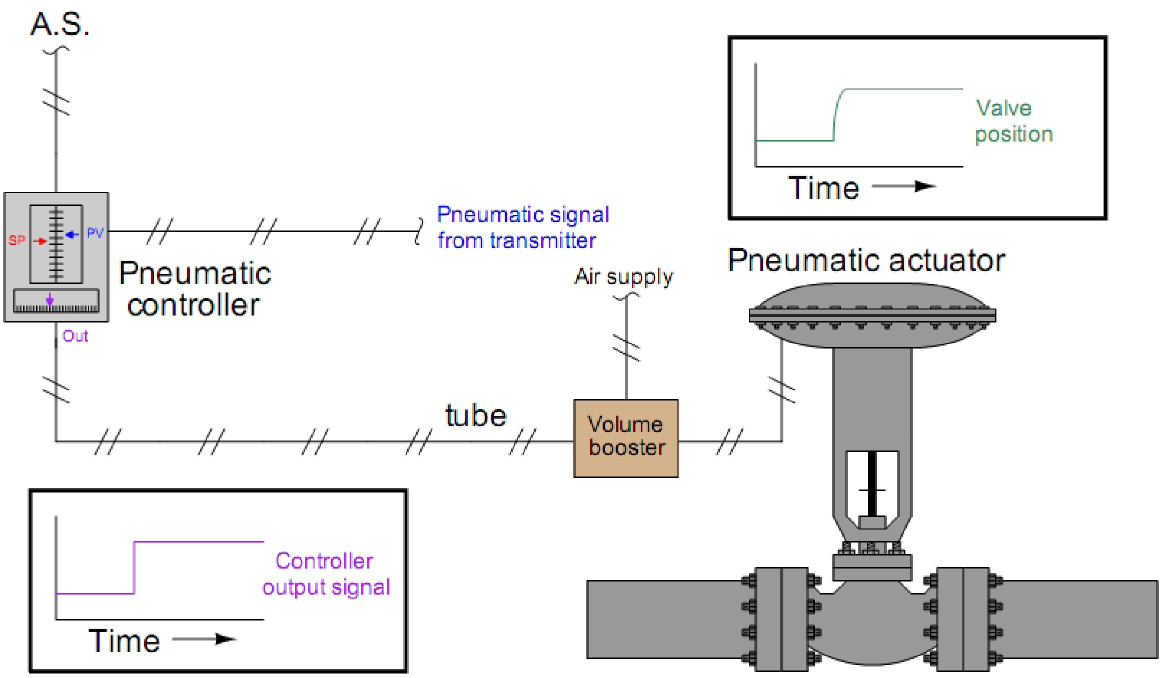
FIG. 6.2f

Electropneumatic force-balance positioner.

CONVERSOR IP



BOOSTERS



VÁLVULAS INTELIGENTES

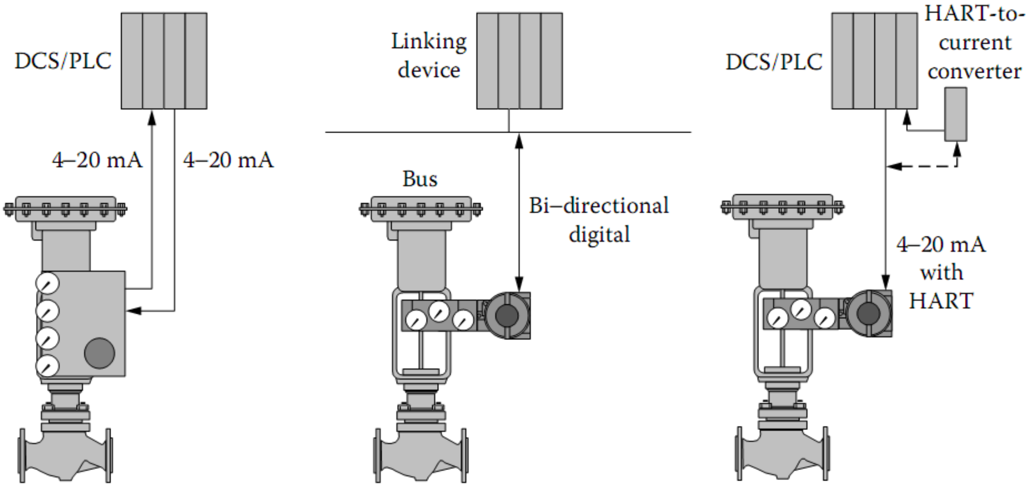
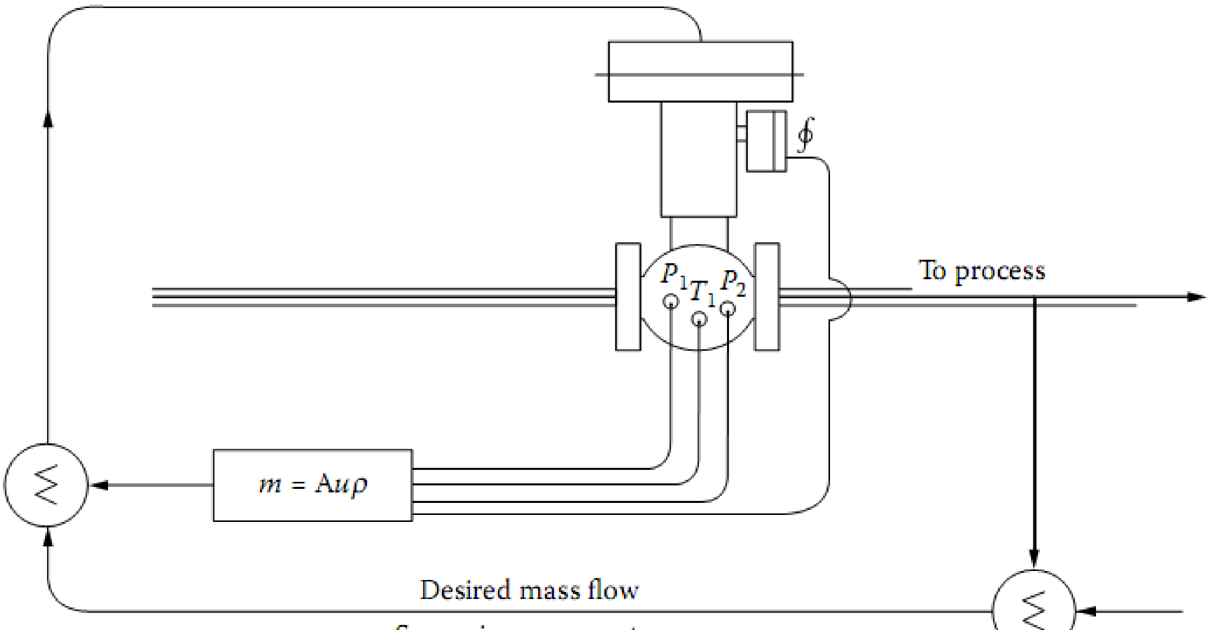


FIG. 6.11c
Wiring requirements of providing position feedback in analog (left), Fieldbus (center), and HART (right) systems.

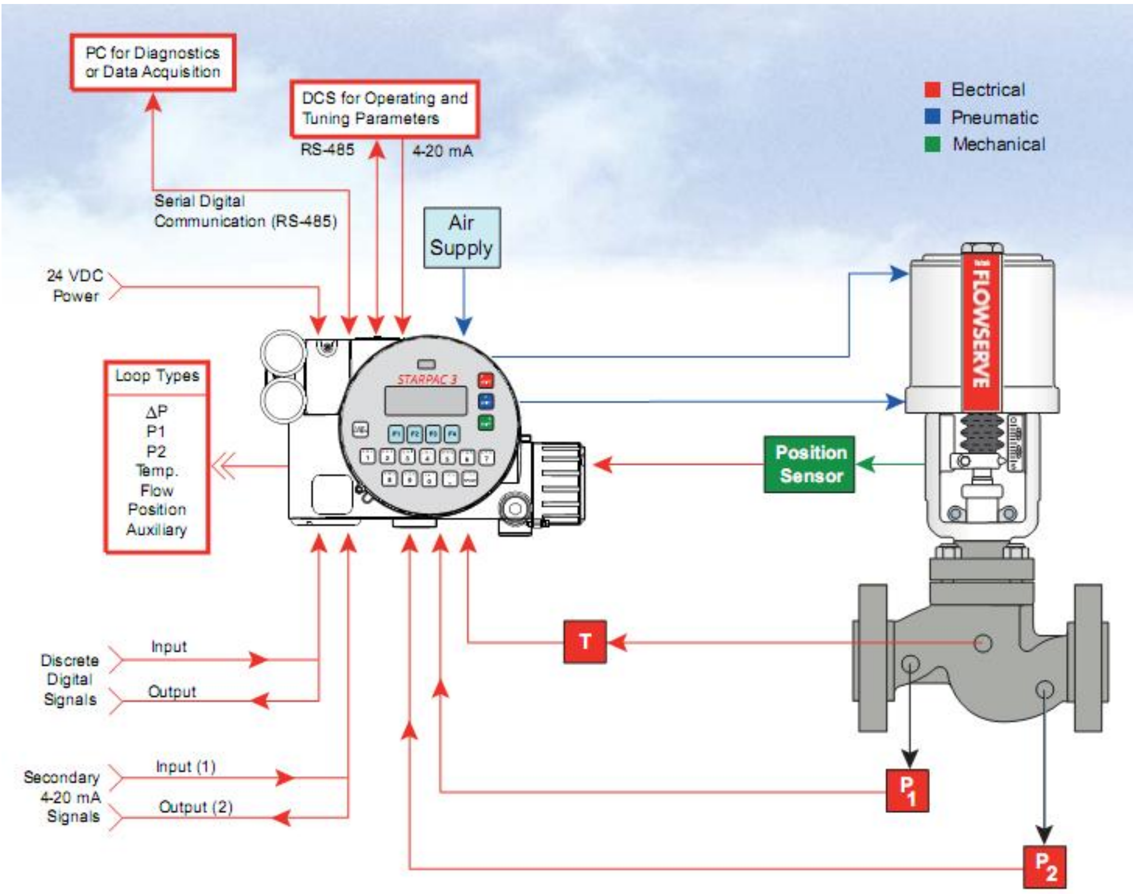


$$A = N_3 C_v \phi(\text{ft}^2);\ U = N_2\sqrt{P_1 - P_2}\ (\text{ft/s});\ \rho = N_1 \gamma P_1 P_2 / T_1\ (\text{lbs/ft}^3)$$

A = Area of valve opening
C_v = Valve capacity coefficient
m = Mass flow, lbs/s
N_1, N_2, N_3 = Numerical constants
P_1 = Absolute inlet pressure, lbs/ft^2
P_2 = Absolute outlet pressure, lbs/ft^2

T_1 = Inlet temperature, °R
U = Orifical velocity, ft/s
γ = Specific weight, lbs/ft^3 @ 70°F and 14.7 psia
ϕ = Fractional valve travel
ρ = Density of flowing gas (lb/ft^3)


VALTEK


PC for Diagnostics or Data Acquisition
DCS for Operating and Tuning Parameters
RS-485
4-20 mA
Electrical
Pneumatic
Mechanical
Serial Digital Communication (RS-485)
Air Supply
24 VDC Power
FLOWSERVE
Loop Types
ΔP
P1
P2
Temp.
Flow
Position
Auxiliary
STARPAC 3
Position Sensor
T
Discrete Digital Signals
Input
Output
Secondary 4-20 mA Signals
Input (1)
Output (2)
P1
P2